THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

VOL. XX. No. 492—23RD YEAR.] LONDON, AUGUST 15, 1871. [Subscription per Annum. { 15s. in Advance. 18s. Credit.] DOUBLE No. Price 1s.

RAMSAY'S NEWCASTLE CANNEL COAL. Analysis—10,000 cubic feet of gas per ton of coal; 26-candle gas; 13¼ cwt. coke per ton of coal.

RAMSAY'S PATENT CONDENSED COKE.

DO. GARESFIELD COKE.

RAMSAY'S FIRE-CLAY ARTICLES.

GAS-RETORTS, introduced 1828. FIRE-BRICK WORKS, established 1804. FIRE-CLAY SANITARY PIPES, CHIMNEY-TOPS, and all Goods made of Fire-Clay. The Fire-Clay is worked from Blaydon Main Colliery, is of excellent quality, and no expense spared in perfecting every article. The FIRE-BRICKS (marked "RAMSAY") are to be seen in all parts of the world, and the Works are the most extensive in the Kingdom.

Manufactories—Derwenthaugh, Swalwell, and Hebburn Quay, near Newcastle-on-Tyne; and London Wharves—Falcon Wharf, No. 80, Bankside; and Honduras Wharf, Cubit Town. Large stocks kept.

Address G. H. RAMSAY, NEWCASTLE-ON-TYNE.

GEORGE GLOVER & CO.,

Patentees of the Standard Gasometers for the Government, and of the

IMPROVED DRY GAS-METERS.

These Meters are warranted to measure correctly and not to vary. Their acknowledged superiority has brought them into general use more rapidly than any Meters hitherto manufactured.

To meet the increasing demand, G. GLOVER AND Co. have just entered on possession of extensive premises adjoining their present Works in Ranelagh Road, and they are now prepared to execute promptly, orders to any extent. They keep in stock all sizes of Meters up to 200 lights. In cases of haste, on the receipt of a telegram early on one day, their Meters can be delivered next day in any part of England, and in the large towns in Scotland.

Particulars and lists of prices forwarded on application to—

RANELAGH ROAD, PIMLICO, LONDON, S.W.;

236, GEORGE STREET, GLASGOW;

OR

15, MARKET STREET, MANCHESTER.

COWEN'S PATENT FIRE-CLAY RETORTS.

JOSEPH COWEN and CO.,

BLAYDON BURN, NEAR NEWCASTLE-ON-TYNE,

Were the only parties to whom a PRIZE MEDAL was awarded at the GREAT EXHIBITION of 1851, for "GAS-RETORTS and OTHER OBJECTS in FIRE-CLAY," and they have also been awarded in the INTERNATIONAL EXHIBITION of 1862, the PRIZE MEDAL for "GAS-RETORTS, FIRE-BRICKS, &c., for EXCELLENCE of QUALITY."

J. C. and Co. have been for many years the most extensive Manufacturers of Fire-Clay Retorts in the United Kingdom; and orders for Fire-Clay Retorts of all shapes and dimensions, Fire-Bricks, and every other article in Fire-Clay, are promptly executed at their Works as above.

COWEN'S GARESFIELD COALS.

Coal Office,

QUAY SIDE, NEWCASTLE-ON-TYNE.

FIRST PRIZE IN THE PARIS EXHIBITION.

JOHN RUSSELL and CO.,

THE OLD TUBE-WORKS,

CHURCH HILL, WEDNESBURY;

ALMA WORKS,

WALSALL, STAFFORDSHIRE;

and 69, UPPER THAMES STREET, LONDON,

Original Manufacturers of Wrought-Iron Gas-Tubes, and Holders of the present Patents; Inventors and First Makers of LAP-WELDED FLUES for Steam-Boilers.

J. R. and Co. make all kinds of Tubes and Fittings for Gas, Steam, and Water, and the largest orders may be executed in a few days.

Gun Metal, and all other kinds of Cocks, Stocks, Dies, and Taps, Galvanized Tubes, &c.

N.B.—All goods thoroughly tested before sent out, and warranted.

JOHN BENT & SON,

WET AND DRY GAS-METER

AND

STREET-LAMP

MANUFACTURERS,

BELL BARN ROAD, BIRMINGHAM.

ESTABLISHED 1830.

All materials found for the alteration of Public Lamps for lighting with the Rod. Regulators with Lava Burners.

BLAYDON BURN AND LOW BENWELL FIRE-CLAY RETORT AND FIRE-BRICK WORKS,

NEAR NEWCASTLE-ON-TYNE.

WILLIAM COCHRAN CARR begs most respectfully to thank the Metropolitan, Provincial, and Continental Gas Companies for their patronage for several years past, and to intimate that he has rebuilt and enlarged his extensive premises for the manufacture of CLAY RETORTS; and that he is now prepared to execute the largest orders with punctuality and despatch. Orders for FIRE-CLAY RETORTS, of all shapes and sizes, FIRE-BRICKS, and all other articles in Fire-Clay, executed on the shortest notice, and on the most reasonable terms.

London Agents: JAMES LAWRIE & CO.,

63, OLD BROAD STREET, CITY, LONDON.

SCOTTISH CANNEL COAL.

J. & W. ROMANS, Consulting Gas Engineers and Coal Factors, of Edinburgh and London, CONTRACT for supplying any quantity of COAL and CANNEL.

They are also Contractors for leasing Gas-Works, for supplying, erecting, or repairing gas apparatus and fire-clay goods.

Messrs. ROMANS, being lessees of several Gas-Works, have their Cannels tested in the ordinary working process, thus securing for their customers a guarantee beyond mere laboratory experiments.

Analysis, prices, and other information will be forwarded on application to their Offices, 8, Forth Street, EDINBURGH; 1, Walbrook, Mansion House, LONDON, or to the "Crown Wharf," Thomas Street, Limehouse, LONDON, where stocks of house, steam, and gas coal are always on hand.

Coal, machinery, fire goods, &c., shipped to all parts of the world.

LESMAHAGO GAS COAL,

AUCHINHEATH COLLIERY,

LESMAHAGO N.B.

JAMES FERGUSON & CO.

LESSEES SINCE 1832.

LONDON AGENTS:

JAMES LAWRIE & CO.,

63, OLD BROAD STREET, E.C.

CONTINENTAL AGENTS:

LA COUR & WATSON,

LEITH.

GEORGE GLOVER AND CO.,

Patentees of the Standard Gasometers for the Government,

TWO MEDALS,

LONDON, 1862.

HAVE OBTAINED THE

HIGHEST

PRIZE

FOR

SILVER MEDAL,

PARIS, 1867.

IMPROVED DRY GAS-METERS AND GASOMETERS,

AT THE

PARIS EXHIBITION.

RANELAGH WORKS, RANELAGH ROAD, PIMLICO LONDON, S.W.;

AND 236, GEORGE STREET, GLASGOW.

C. & W. WALKER'S

DOUBLE-FACED GAS-VALVES FOR LARGE MAINS.

These Gas-Valves for large bores are specially constructed of unusual strength and solidity. The Valve itself is a rigid wedge of cast iron, having two perfectly scraped surface facings, fitting between the two in the body, which are also surfaced. They are guaranteed absolutely tight under any chemical or other test for mains of the largest diameter, at a very moderate price.

Midland Iron-Works, Donnington, near Newport, Shropshire; 8, Finsbury Circus, London.

HENRY HOWARD & CO.,

COOMBS WOOD PATENT TUBE-WORKS.

OLD HILL, near DUDLEY,

MANUFACTURERS OF

HOWARD'S PATENT IMPROVED WROUGHT-IRON TUBES,

FOR GAS, STEAM, AND WATER;

Also ORDINARY WELDED WROUGHT-IRON TUBES and FITTINGS,

FOR GAS, STEAM, & WATER, EITHER BLACK, GALVANIZED, OR ENAMELLED.

CORE BARS FOR IRONFOUNDERS, STOCKS, TAPS, AND DIES, IRON COCKS, &c.

London Agent—W. G. DAVIS, 2, Brabant Court, Philpot Lane, E.C.

SILVER MEDAL, PARIS EXHIBITION, 1867.

LLOYD AND LLOYD,

ALBION TUBE-WORKS, BIRMINGHAM,

MANUFACTURERS OF

WROUGHT-IRON TUBES AND FITTINGS

For Gas, Steam, Water, &c.

SOLE LICENSEES AND MANUFACTURERS for the United Kingdom of

THE LAVENANT PATENT ENAMELLED TUBES AND FITTINGS.

LAP-WELDED IRON & HOMOGENEOUS METAL TUBES

For Locomotive, Marine, and Stationary Boilers.

Boiler-Tube Ferrules, Gun-Metal Gland Cocks, Water-Gauges, Whistles, &c.; Stocks, Taps, and Dies for Screwing, and Gas-Fitters Tools of all kinds.

London Offices: No. 4, Cloak Lane, Queen Street, E.C.

WAREHOUSES:

LONDON: No. 157, Upper Thames Street, E.C. LIVERPOOL: No. 63, Paradise Street. MANCHESTER: Barlow's Croft, Chapel Street, Salford. PARIS and LILLE.

WILLIAM INGHAM AND SONS,

WORTLEY FIRE-BRICK AND RETORT WORKS,

Near

Leeds.

W. INGHAM and SONS, having for many years been extensively engaged in the Manufacture of

RETORTS AND FIRE-BRICKS FROM THE CELEBRATED WORTLEY FIRE-CLAY,

beg to call especial attention to their RETORTS, which have for many seasons proved to be unsurpassed in quality by any in the Kingdom, their FREEDOM FROM CRACKS and the ADHESION OF CARBON rendering them worthy the attention of all parties interested in the making of Gas.

The Works are of such magnitude as to ensure the prompt execution of orders to any extent.

Estimates for Setting, or Bricklayers sent when required.

GAS OVENS IN SEGMENTS OF EQUAL QUALITY.

A large Stock of Fire-Bricks, Fire-Clay, Terra Cotta, and Drain-Pipes of all Sizes kept in London at Mr. ALFRED WILLIAMS, Wharf, 64, Bankside, Southwark, where all particulars of Prices, &c., may be obtained.

N.B.—*Export orders continue to have prompt attention.*

TRADE MARK.

THE MEDAL FOR 1862.

The only Prize Medal awarded for TUBES & FITTINGS.

CROWN TUBE-WORKS,

WEDNESBURY, STAFFORDSHIRE.

WAREHOUSE: SOUTHWARK STREET, LONDON.

JAMES RUSSELL & SONS, LIMITED,

PATENTEES & FIRST MAKERS OF WROUGHT-IRON TUBES,

ONLY MAKERS OF HOMOGENEOUS METAL TUBES.

MANUFACTURERS OF

TUBES and FITTINGS for GAS, STEAM, and WATER;

LAP-WELDED, LOCOMOTIVE, MARINE, and other BOILER TUBES;

HYDRAULIC TUBES, BEDSTEAD TUBES, WELL TUBES, TELEGRAPH POSTS, COILS, &c.;

GAS-FITTERS TOOLS, VALVES, COCKS, &c.

THOMAS PIGGOTT & CO.,

(Established 1822,)

SPRING HILL, BIRMINGHAM,

MANUFACTURERS OF

TELESCOPIC & SINGLE GASHOLDERS,

CAST & WROUGHT IRON TANKS FOR DITTO;

PURIFIERS, CONDENSERS, SCRUBBERS, RETORTS, VALVES;

IMPROVED WROUGHT-IRON RETORT-LIDS, CROSS-BARS, & SCREWS;

AND GAS APPARATUS OF EVERY DESCRIPTION.

CAST AND WROUGHT IRON GIRDERS, BRIDGES, AND ROOFS,

STEAM-ENGINE BOILERS, & GENERAL WROUGHT-IRON WORK.

London Agents: PORTER and LANE, 172, FENCHURCH STREET, E.C.

D. BRUCE PEEBLES & CO.,

ENGINEERS, WET AND DRY GAS-METER MANUFACTURERS,

BRASSFOUNDERS, & GAS APPARATUS MANUFACTURERS,

FOUNTAINBRIDGE WORKS, EDINBURGH.

SOLE MANUFACTURERS OF

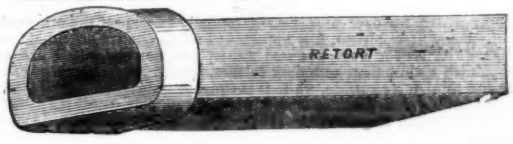
Peebles' Patent Wet and Dry Gas-Meters in Tin-Plate Cases, with Tongue and Groove Joints.

IMPROVED WET METERS IN CAST-IRON CASES.

STATION-METERS, GOVERNORS, EXPERIMENTING METERS, PHOTOMETERS, PRESSURE-GAUGES, &c.

KING BROTHERS,

STOURBRIDGE FIRE-BRICK AND RETORT WORKS.

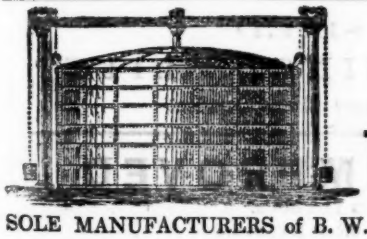


KING BROTHERS beg especially to call the attention of Gas Companies to the superiority of their Retorts, which are made from the celebrated STOURBRIDGE FIRE-CLAY. Mr. King has patented a Kiln for burning Retorts, by which Patent all Cold Air is excluded from the Kiln while burning, thus rendering them FREE FROM CRACKS AND CORRECT IN FORM. By great care in Manufacturing, combined with the advantages in burning, a VERY SMOOTH SURFACE is obtained, rendering them less liable to carbonize.

Retort Ovens, Fire-Bricks, Guards, Saddles, Rabbitted Bars, Flues, and Quarries, are all Manufactured of the same quality of Clay.

Every Retort and Brick is branded "King Brothers, Stourbridge."

Agent in Ireland—Mr. JAMES FURNESS, No. 3, FOWNES STREET, DUBLIN.



IMPROVED GAS APPARATUS,

FOR CITIES, TOWNS, VILLAGES, &c.,

INVENTED AND MANUFACTURED BY

W. C. HOLMES & CO.,

WHITESTONE IRON-WORKS, HUDDERSFIELD.

SOLE MANUFACTURERS of B. W. THURSTON'S IMPROVED SCRUBBER, CONDENSER, and WASHER, in use in many of the principal Gas-Works on the Continent.

PATENTEES of the IMPROVED COMBINED PURIFYING APPARATUS, so eminently adapted for Exportation.

ESTIMATES, PLANS, and SPECIFICATIONS PREPARED for BUILDINGS and APPARATUS.

Prospectus, Price Lists, &c., on application.

LONDON OFFICES—57, GRACECHURCH STREET, CITY

*** *Please address letters to Huddersfield.*

REFERENCES TO NEARLY 300 GAS-WORKS.

THE FARNLEY IRON COMPANY, LIMITED,

FARNLEY, near LEEDS,

Possess special advantages for the prompt and efficient execution of large orders for

FIRE-CLAY RETORTS & FIRE-BRICKS,

Of every shape and size, and of the best quality; also for their *other productions* in Fire-Clay and Terra-Cotta, including their well-known White and Coloured GLAZED BRICKS.

The F. I. Co. have the exclusive right to make and sell Fraser's Patent "Ribbed" Retorts in Fire-Clay.

Apply as above, or at their Offices,

3, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W., or at 46½, QUEEN STREET, HULL.

E. J. & J. PEARSON,

DELPH & TINTAM ABBEY FIRE-CLAY & BRICK WORKS,

STOURBRIDGE,

PROPRIETORS OF

BEST GLASS-HOUSE POT & CRUCIBLE CLAY;

MANUFACTURERS OF

GLASS-HOUSE POTS, CRUCIBLES, GAS-RETORTS, & FIRE-BRICKS OF EVERY DESCRIPTION.

FLETCHER AND MURPHY,

GARRATT STREET WORKS, OLDHAM ROAD, MANCHESTER;

Manufacturers of

IMPROVED CONSUMERS WET GAS-METERS

IN CAST-IRON CASES,

THE UNVARYING WATER-LINE GAS-METER,

AND

IMPROVED DRY GAS-METERS;

STATION-METERS OF ALL SIZES, with PLANED JOINTS;

GOVERNORS, PRESSURE AND EXHAUST REGISTERS, TEST HOLDERS,

And all kinds of Experimental Gas Apparatus.

1862.

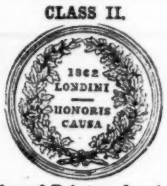
PATENT ANTIMONY PAINT.

MADE ONLY BY

GEORGE HALLETT & CO.,

296, ROTHERHITHE, LONDON, S.E.

CLASS II.



This Paint having been in general use over nine years (especially in some of the principal Gas-Works), and proved itself the best light-coloured Paint produced for resisting the influence of vitiated atmospheres, it is important that its qualities should be more widely known.

It is not discoloured like white lead in a sulphuretted atmosphere, nor washed off like white zinc; and its light colour reflecting heat, produces much less expansion of gas in holders painted with it than with dark colours, besides rendering them much more sightly. Its specific gravity is so much below white lead that the same weight will cover one-third more surface, while it is equal in body; and its price being about the same (30s. per cwt.), it is actually one-third cheaper. From experience, its manufacture is greatly improved, and it is quite suitable for all purposes in which white lead is employed.

Reference is kindly permitted by the Engineers of the City of London, Commercial, London, and Surrey Consumers Gas Companies, who pronounce it the best Paint known for their purposes.

N.B.—Antimony Paint, COVERING SO MUCH MORE WORK, costs about 20s. per cwt., as compared with White Lead at 30s. per cwt.; a similar economy arises from its use in Steam and Gas Joints, for which purpose it is superior to White Lead.

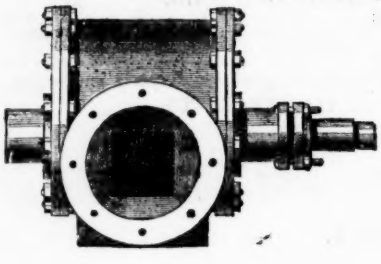
C. & W. WALKER

CONSTRUCT THE LARGEST SIZED

GASHOLDERS, TELESCOPE AND SINGLE-LIFT,

Midland Iron-Works, Donnington, near Newport, Shropshire; 8, Finsbury Circus, London.

BEALE'S GAS-EXHAUSTER IMPROVED.



FROM 250 TO 250,000 CUBIC FEET PER HOUR.

Since Mr. BEALE'S retirement, the Oldest Makers are

J. BURTON, SONS, AND WALLER,

MAKERS OF ENGINES, MACHINERY, and IRONWORK for GAS-WORKS.

Efficient and durable TAR, LIQUOR, and SYPHON PUMPS.

GAS-VALVES in stock, 2 inches to 30 inches.

SELF-ACTING BYE-PASS VALVES, with Lid and Relieving Lever,

ROTATORY, TUMBLER, and CAPILLARY WATER DISTRIBUTORS for SCRUBBERS.

EXHAUSTERS from 3000 to 30,000 per hour in stock.

HOLLAND STREET, BLACKFRIARS, LONDON, S.E.,

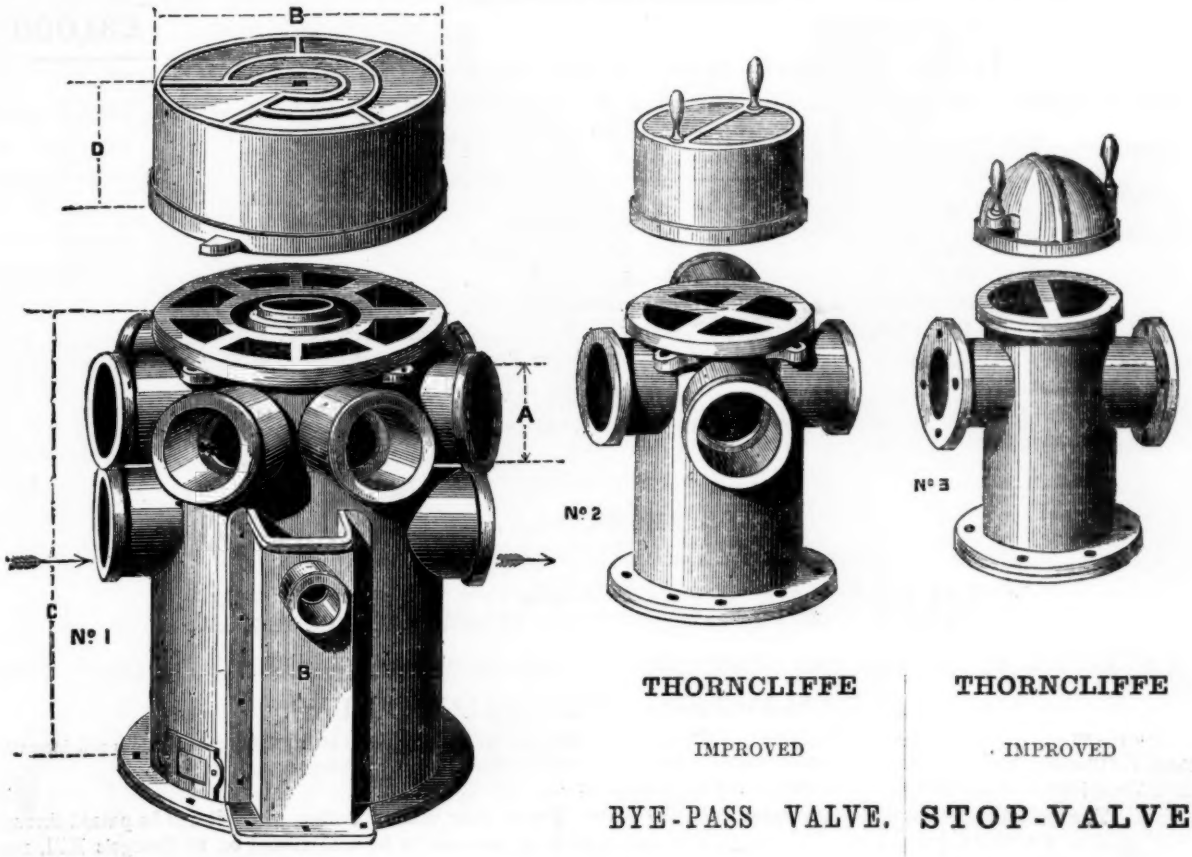
Between Blackfriars' and Southwark Bridges.

THE THORNCLIFFE IMPROVED CENTRE-VALVE,

MANUFACTURED BY

MESSRS. NEWTON, CHAMBERS, & CO.,

THORNCLIFFE IRON-WORKS, NEAR SHEFFIELD.



Sizes of the

THORNCLIFFE IMPROVED CENTRE-VALVE.

		Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
A	Bore of Pipe...	4	5	6	7	8	9	10	12
B	Diam. of Body.	16	20	23	26	28	31	34	40
C	Height of Tank.	33	35	38	43	46	48	51	56
D	Depth of Cover.	8	9	10	11	12	13	14	16
	Total height...	41	44	48	54	58	61	65	72

THORNCLIFFE IMPROVED BYE-PASS VALVE.

SIZES

From 3 ins. upwards.

THORNCLIFFE IMPROVED STOP-VALVE.

SIZES

From 3 ins. upwards.

In all cases the Covers are cast heavy enough to resist any required pressure.

The advantages derived from the adoption of these Valves are so manifest and cardinal that in the immediate character of the change—the simplicity of the machine—the facility affording for cleaning out connexions between Valve and Purifier—the perfect collection and delivery by suitable overflow of the ammonia, at a greatly diminished depth from ground-line over the old form of Valve—the advantage of connecting on the same level, and at any angle, or opposite to each other, the inlet and outlet pipes without dip or rise—the clear acquisition of space in the purifying-house, by being able to place the boxes nearer together, the new Valve being entirely under the floor—and lastly, though of the greatest importance, the passage of crude and unpurified gas during the change is minimized to the merest fraction, thus preventing the fouling by impure gas the delicate machinery and easily affected exposed movements of the station-meter, thereby preventing the introduction of the enemy (unpurified gas) into the gasholder. Also a dead abutment is offered to all back pressure, imparting thereby to the gauges, governors, and hydraulic seals, a steadiness of action never realized with the once famous, but now fast becoming obsolete, Hydraulic Centre-Valve.

These Valves may be made of any size to suit any position of boxes, to stand any amount of pressure, warranted and tested with gas before leaving the manufactory, prepared to work any number of boxes in rotation—say, two, three, four, five, six, or eight—and for all Valves above 12-inch ports a suitable rack-and-pinion movement is attached if preferred. These Valves (specially arranged) are applicable to inlet or outlet pipes of gasholder, to act as Bye-pass Valves to meters, governors, exhauster, condensers, scrubbers, washers, driers, and duplicate systems of hydraulic main; also to act as Stop-Valves on special mains about the works. Where it is important no impediment be offered to tar or ammoniacal liquor, the same having uninterrupted flow to the general tar-well on the works, and for which purpose the slowly changed, often disordered, and at all times obstructive Slide-Valve (challenging the best of them) is superseded by the exceedingly simple, instantaneously changed Dome-Top Valve, which also carries so marked an index, whether open or shut, at any distance from close observation, providing the Valve can be seen at all. See sketch in perspective, No. 3.

London Office—34, LONDON WALL, MOORGATE STREET, E.C.

WEST SURREY WATER COMPANY.

Incorporated by Special Act of Parliament.

LIABILITY LIMITED TO £10 PER SHARE.

CAPITAL—SHARES—2500 OF £10 EACH	**£25,000**
„ BORROWING POWERS	**6,000**
	£31,000

Issue of 1250 Shares of £10 each, £12,500.

Deposit on Application for Shares £1 per Share, and £1 on Allotment. Calls not to exceed £2 each per Share, and can only be made at intervals of not less than Three months.

DIRECTORS.

JOHN HOOK, Esq., Woodham Hall, Chertsey, Surrey, *Chairman.*
I. DELVALLE, Esq., Stoke Newington Green, N.
JASON GURNEY, Esq., Star Brewery, Walton-on-Thames, and Hounslow, W.
JOHN M'MILLAN, Esq., 7, Westminster Chambers, Victoria Street, S.W.
ARTHUR TELFORD SIMPSON, Esq., Cadogan Road, Surbiton, Kingston-on-Thames.

BANKERS.

THE IMPERIAL BANK, LIMITED, 6, Lothbury, E.C.
Messrs. RANSOM, BOUVERIE, & Co., 1, Pall Mall East, S.W.
Messrs. LA COSTE & STIKEMAN, Chertsey, Surrey.

SECRETARY.

CHARLES ELEY, Esq.

OFFICES.

5, WESTMINSTER CHAMBERS, VICTORIA STREET, WESTMINSTER, S.W.

ABRIDGED PROSPECTUS.

"The West Surrey Water Act, 1869," secures to the incorporated Company the exclusive right of supplying the populous and increasing districts of Chertsey, Walton-on-Thames, Hersham, Oatlands Park, Weybridge, Cobham, Byfleet, and Shepperton, with Water.

The objects of the undertaking may be briefly stated as follows, viz.:—

To supply the district with water taken from the River Thames, near Walton Bridge, where it will be passed through filter-beds, pumped into the mains, and conveyed to a reservoir to be constructed on St. George's Hill, near Oatlands Park, an altitude of upwards of 200 feet above the level of the River.

To give a constant supply, the works being so arranged that the service-pipes and reservoir will always be charged, the reservoir supplying the service-pipes when the pumps are not at work.

A provisional agreement has been entered into with the well-known firm of Messrs. Docwra and Simpson to execute these works for the sum of £23,500; and the land required can be obtained upon favourable terms.

The district contains houses of an annual value exceeding £70,000, constantly being increased by building operations; there are, in addition, railway stations, breweries, and other large establishments at present indifferently supplied with water, all of which will become consumers with great advantage to themselves and profit to the Company.

One-half of the authorized Share Capital has already been subscribed; the remainder, £12,500, is now offered to the public.

The dividends paid by existing Water Companies afford the best evidence of the remunerative return which may be realized upon Capital invested in such undertakings, and few have been started with better prospects of success than this. The following is the present market price of the Shares of some of the leading Water Companies (ex dividend which has just been paid):—

	Paid per Share.	Market Price.
Chelsea	£100 0 0	£122 0 0
East London	100 0 0	122 0 0
Grand Junction	50 0 0	85 0 0
Kent	100 0 0	122 0 0
Lambeth	100 0 0	122 0 0
New River	Not obtainable.	
Southwark and Vauxhall	100 0 0	122 0 0
West Middlesex	61 0 0	113 0 0

Applications for Shares to be made to the Bankers, or delivered to the Secretary, at the Offices of the Company, No. 5, Westminster Chambers, Victoria Street, Westminster, S.W., accompanied by a payment of One pound per Share upon the number of Shares applied for.

Prospectuses and Forms of Application for Shares may be obtained at the Offices of the Company, the Bankers, or of A. S. Wildy, Esq., 30, Old Broad Street, E.C.

THE WEST SURREY WATER COMPANY.

Notice is hereby given that the Lists of Application for Shares in this Company will be closed on the 19th inst. for London, and on the 21st inst. for Country applications.

5, Westminster Chambers, Victoria Street, Aug. 11, 1871.

CHARLES ELEY, Secretary.

TANGYE BROTHERS & HOLMAN,

10, LAURENCE POUNTNEY LANE, LONDON, E.C.;

And BIRMINGHAM (TANGYE BROS.), CORNWALL WORKS, SOHO.

SOLE MAKERS OF

MORTON'S PATENT SELF-SEALING RETORT-LIDS,

WITH HOLMAN'S PATENT ECCENTRIC FASTENINGS.

Over 1000 of the Patent Retort-Lids and fastenings already supplied to the great works of The Gas Company at Beckton.

Several hundreds in use at the works of the London Gas Company.

FIG. 1.

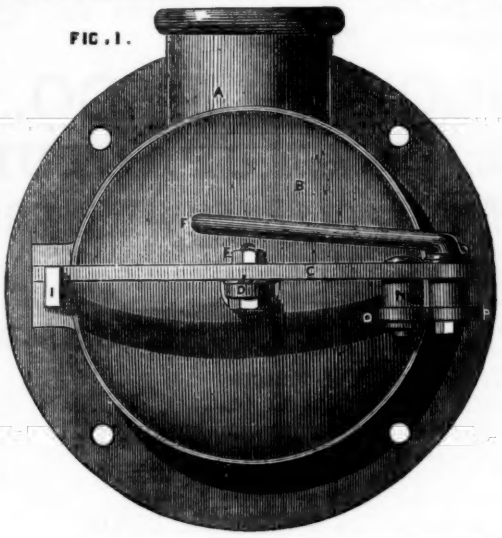
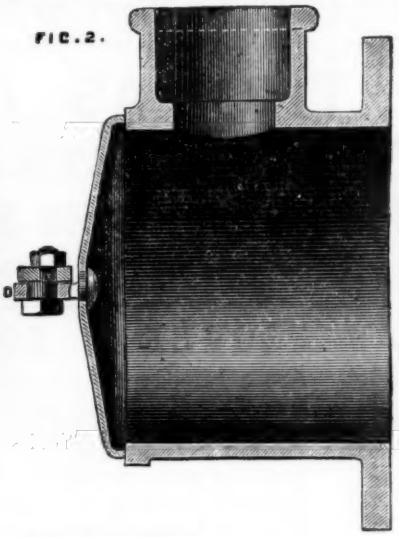


FIG. 2.



Adopted in the Gas-Works at

LIVERPOOL,
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NOTTINGHAM,
ST. ALBANS,
BURSLEM,
BOURNEMOUTH,
WINDSOR,
BOSTON,
&c., &c.

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Alliance and Dublin Gas Company.
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Chartered Gas Company, Westminster.
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Dublin Consumers Gaslight and Coke Company.
Dunstable Gas-Works.
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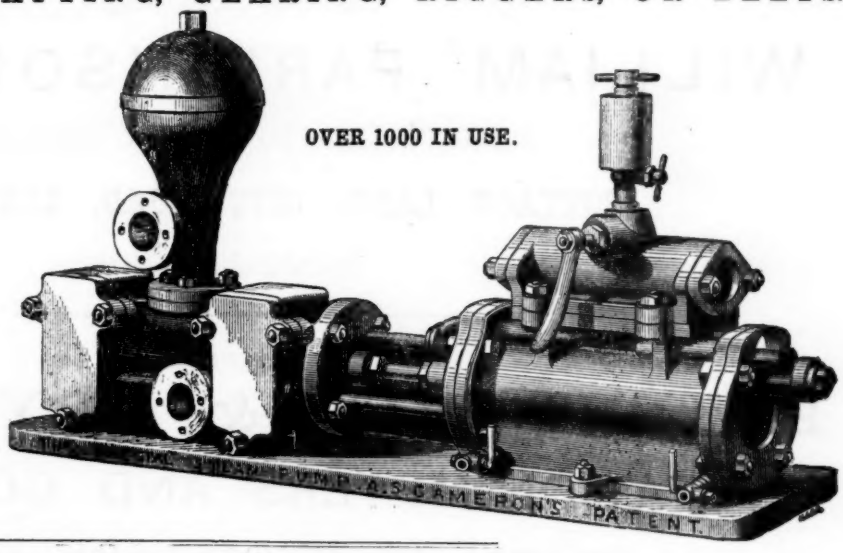
Lewes Gas-Works.
Louth Gas Company.
Middlesbro' Gas-Works.
Northampton Gas Company.
Phœnix Gas-Works, London.
Richmond Gas Company.
Rio de Janeiro Gas Company.
Reading Gas-Works.
Shipley Gas-Works, near Bradford.
St. Albans Gas-Works.
Sutton, Southcote, and Drypool Gas Company, Hull.
St. Helen's Gas Company, Lancashire.
Windsor Royal Gaslight Company.
Wandsworth and Putney Gas Company.
Woolwich Equitable Gas Company.
Western Gas-Works, Kensal Green.



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IMPORTANT TESTIMONIALS.

Manager's Office, Local Board Gas-Works, Middlesborough, March 19, 1868.

Dear Sirs,—In reply to your inquiry, I beg to say that the "Special" Steam-Pump, which you supplied to these works some months ago, has been at work ever since for pumping tar and ammonia water. I like it well, and am more than satisfied, for I am really pleased with its mode of doing double duty.

I am, very respectfully yours.

JOHN DUNNING, Manager.

Messrs. Tangye Brothers and Holman.

Richmond Gas Company, Manager's Office, Gas-Works, Richmond, June 17, 1868.

Dear Sirs,—I have the pleasure in stating that the three "Special" Steam-Pumps which we have in use—viz., one for water, one for pumping liquor through the scrubbers, and the other for filling tar barges, &c., are working well in every respect, and, I think, cannot be too highly recommended.

Yours truly,

JAMES ELDRIDGE, Manager.

Messrs. Tangye Brothers and Holman.

Sutton, Southcote, and Drypool Gas Company, Hull, May 1, 1871.

Gentlemen,—In reply to your note No. 410, April 29, I am very glad to inform you, that in a few hours after I got the pump started, and after I had written you, it did its work beautifully, and has continued to do so, throwing one day 4000 to 5000 gallons per hour, although you say 3250 gallons is its capacity. It is a splendid pump, the best I ever saw, and has just emptied a tank 82 feet diameter by 16 feet deep in 100 hours. I should have written to you some days ago had your note come earlier.—Yours truly,

F. W. OLDFIELD, Manager.

London, 1851. New York, 1853. Paris, 1855. London, 1862.

Dublin, 1865. Paris, 1867.

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PATENT DRY GAS-METERS,

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PRESSURE REGISTERS, GAUGES,

EXPERIMENTAL METERS, PHOTOMETERS, GASHOLDERS, &c., &c.

WATER METERS.

W. P. & Co. beg to state that they are now prepared to supply Station-Meters with planed joints.

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TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion, must be authenticated by the name and address of the writer; not necessarily for publication, but as a guarantee of good faith.

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THE JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, AUGUST 15, 1871.

Notes upon Passing Events.

MR. BAZALGETTE has tardily received the honour that was his due as the engineer of two of the most remarkable public works of the metropolis. For a very inadequate salary he has occupied a very responsible position, in which he has had at times quite as much difficulty with his masters as with his men. If he had been restricted to the income of his appointment, and not been permitted to take professional fees which his public reputation brought to his door, he might have starved at his post. Certainly, the main drainage is much the greater work of the two. But it is out of sight, and therefore less appreciated, like divers coadjutors whose work, whose learning, whose unrecorded labours Mr. Bazalgette has used—we will not say appropriated—without the slightest acknowledgment; this may be seen in his published biography. But that is the weakness of these worthy fathers of families, "whose only care is to increase their store," and in that pursuit suck honey from everybody's flowers—a system which makes professional men more prosperous than popular. There are successful men in the engineering profession who followed the selfish, egotistical system, but not the greatest men. Be that as it may, Mr. Bazalgette, in spite of some blunders like that at the Crossness Pumping-Station, has, on the whole, done his work well, and made such display with the Embankment that it was almost impossible to pass him over without some public recognition of his services. The Embankment, when completed from Blackfriars Bridge to Chelsea, with a new Battersea Bridge, will be one of the finest things in Europe. It is a pity that Mr. Bazalgette's temperament prevented him from consulting an architect in the ornamentation of the Embankment. With rougher work and broader outlines much finer effects might have been produced. But let that pass. We do not quite understand why he was made a C.B. instead of being knighted. "Sir Joseph" would have been more useful professionally, and looked much larger in print, while the red riband can only be displayed on special occasions. In every profession a knight gets chances of practice that do not fall to plain misters. But perhaps the Metropolitan Board objected to their officer having obvious precedence over themselves. According to official theory, the title of C.B. is only bestowed on those who have been in the service of the Crown. Whether Mr. Bazalgette's honour is a special exception, or whether reference was had to his employment in a subordinate position by the Admiralty, we have not heard; at any rate, if such things are to be given away, Mr. Bazalgette had a fair title to the star and red riband. Anything which gives a scientific officer additional weight with the Board which employs him, is an advantage to the public. The other day, the Emperor of Germany bestowed an Iron Cross on Dr. Russell, as an acknowledgment of his services in reporting the Franco-German campaign while travelling on the staff of the Crown Prince. Considering the customs of continental Courts, it was a very proper and pretty compliment to pay to a powerful and zealous reporter on the German side. Dr. Russell, when at ease, with his little comforts around him, is a very pleasant writer; although, of course, not the man he was in the Crimea—for time tells on all of us, and most of all on reporters. As a matter of fact, until comfortably settled in Versailles, the *Times* reports were far inferior to those of the *Daily News* and *Standard;* nevertheless, the bestowal of the Iron Cross on Dr. Russell has been the text of homilies by a certain class, or rather of second-class writers, who complain that literature does not get its share of titles and decorations in England. It is the system of foreign Courts to subsidize talent by these cheap retaining fees. It is not our system, and we trust it never will be. It is not the really eminent who desire to be collared and starred and ribanded, but your professional manufacturers of books—your Hepworth Dixons, Blanchard Jerrolds, and others of the same kidney, who exchange mutual admiration in the weekly journals over which they have control.

The Metropolitan Board of Works certainly come out favourably when their works are compared with those executed by the Government. For instance, the Woods and Forests twenty-five years ago obtained parliamentary powers to make a bridge and the Chelsea Embankment, but managed so to muddle away the funds that they only completed a toll-bridge and a little bit of embankment. The new embankment will turn nine acres of mud flat into solid ground, and immensely improve the river. Of the reclaimed ground, part will afford a roadway 70 feet wide, the rest will be converted into ornamental grounds, which will give quite a new character to Chelsea, and perhaps revive the ancient glories of Cheyne Walk. It is stated that the introduction of Portland cement into this work, instead of brickwork, will alone save £21,000, and large sums positively wasted in other sections of the embankment by polishing the granite will not only be saved, but a better effect will be produced than the hammer-dressed face. If the architecture of old Newgate had been studied before the North Embankment was commenced, a vast sum would have been saved, and an infinitely more picturesque effect gained. On the occasion of laying the first stone of the Chelsea Embankment, Colonel Hogg, in the course of his speech, mentioned that, in fifteen years, sewers 400 miles in length had been constructed, at a cost of six millions, by the Board, while the vestries had added 700 miles of connecting sewers. The Board had also carried out the embankment of the Thames, which, when the Chelsea extension was completed, would be three miles in length. They had also completed nine new streets. It must be confessed that any one who takes his place at the Bank, surveys the grand effect of the vista towards Blackfriars, and considers what a thoroughfare will be open within three years all the way to the foot of Battersea Bridge; and if then, shifting his place to the top of the Holborn Viaduct, he takes in all that street and railroad improvement will effect in that time, he will take a much more hopeful view of the metropolitan improvements than he could have done before the Metropolitan Board began to compete with the Corporation of London.

Yet, although so much has been done to facilitate traffic with incidental picturesque effects of great value, one want, of enormous value and extraordinary difficulty, remains—another bridge, to relieve the traffic of London Bridge. All that has hitherto been done to reduce the traffic has produced no appreciable effect. The grand street from Blackfriars Road to the Borough is useful for cabs, but has not apparently touched the heavy traffic. Southwark Bridge, from its steep gradients as much as its situation, seems to do nothing to relieve the crowd of wheels. What is to be done? It is so difficult to raise funds for improvements that are entirely unproductive. But the need of more space for the London Bridge traffic becomes every day more urgent. While Moorgate Street was stopped up for asphalting, there was for several days a continuous block, extending over London Bridge, across the Poultry to the narrow streets behind Finsbury. Æsthetical arguments prevent the adoption of the simplest palliative—we could scarcely call it a remedy—the widening of the carriage-way of London Bridge by taking in the footpaths, and placing some excrescences to serve the same purpose outside. But very soon something must be done. Where the Corporation can find funds for a new bridge to take the dock traffic no one can tell. At present the Common Council has got its hands full of markets, which are, of all speculations, the most ticklish and most uncertain. Witness the unfortunate Lady Burdett Coutts, with the white elephant of Columbia Market, built to satisfy the ambitious taste of an architect, without consulting a single practical man. On this market a quarter of a million has been wasted, and the munificent builder has been made happy by the Corporation accepting it on their own terms. The failure of Hungerford Market is almost forgotten. An attempt is being made to earn a profit out of Farringdon Market, by adapting it to the Holborn Viaduct improvements, and colonizing it from the discontented fruiterers and flower dealers of Covent Garden. The attempt is laudable. The removal of Holborn Bars and the abolition of Holborn Valley have removed all physical difficulties from carriages whose owners desire to patronize a fruit and flower market in Farringdon Street, but who can undertake to say that any temptation will bring West-end customers and coachmen so far along the stones. Perhaps a series of dinners, judiciously bestowed on the customers of Covent Garden and their Jehus, might do the trick. At present, although we admit that the experiment is worth trying, and that the Corporation, in its present political and financial situation, cannot be too audacious, we doubt the success of any attempt to transplant any market.

We have often called attention to the waste of open space in the park attached to Lambeth Palace. Mr. Arthur Arnold, the editor of the *Echo*, has taken the subject up, and bombarded Archbishop Tait with a series of letters praying, as we have prayed, that after reserving a sufficient pleasure-ground for the privacy and dignity of the palace, including a croquet-ground for the clergy who have not forgotten the amusements of curates, the rest of the paradise of cats should be thrown open to the population of Lambeth Marsh—a population which has no country houses, and cannot afford to make an annual trip to Switzerland or the sea-side. In curt but courteous phrases the Archbishop's secretary informs Mr. Arnold that the Archbishop "cannot see it." We can only imagine that his lordship never travels by the South-Western Railway from Waterloo Station. Any one who does can see for himself that anything more waste, more desolate, more useless than Lambeth Park is not to be found, except on a very small scale in the deserted churchyards of the metropolis. A solitary cow may be seen cropping the soot-defiled grass—if her milk is white it says volumes for the chemistry of nature—but as a rule the park is given up to solitude and cats, whose numbers and howlings on a moonlight night are "a caution." Of course, the editor of the *Pall Mall Gazette* sneers at the efforts of the editor of the halfpenny *Echo*, which is not written exclusively "for gentlemen." But then the *Pall Mall*, learned and witty, every day grows more cantankerous, as clever men who fail are apt to do. Our advice to the people of Lambeth is to charge and charge again. Right to the enjoyment of this park they have none, but only a dog-in-the-manger policy would utterly exclude them from a privilege so useless to the resident of Lambeth Palace. Archbishop Tait is a worthy man, but of all things he is afraid of the Mrs. Grundys of his profession.

Whenever—and the time is not far distant—a formal inquiry is made into the working of the Corporation of London, its funds, its machinery, and the work done by arrangements so imposing, the cross-examining counsel will find all the materials of a brief ready to their hands in the *officious*, if not official, record of City proceedings contained in the *City Press*—a paper that cannot be excelled, in its class, for judicious and comprehensive editing. Of course it is the duty of the *City Press* to defend and praise all City transactions, municipal or parochial; but at the same time it records, in the course of business, and in the most innocent manner, facts and figures of a very damaging character. For instance, it is only the other day that the City was in a ferment of indignation at the idea of its trust and charity funds being overhauled by official commissioners. Aldermen, common councilmen, the incumbents of City benefices, churchwardens, beadles, and sextons were equally amazed and furious. But in the *City Press* of the 3rd of August a correspondent opens a case against the management of the Cripplegate charities, which proves more than the hardest things that have been said by the advocates of City charity reform. The accounts of the churchwardens seem to be stated and audited in utter defiance of the rules that are enforced by the Court of Chancery or the Treasury; but that is a trifle into which we will not enter, because a simple statement of figures makes out the case for inquiry plainly enough for our purpose. There are nearly forty charities producing annual incomes of from 12s. to £200 a year, and a gross income of £2400 a year. In the expenses and expenditure which absorb this sum, £250 a year are charged for sundries. The correspondent, "Observer," pertinently "observes:"—

> Now, what does this £250 "sundries" mean? From the nature of the account, it cannot be bad debts. It cannot be commission for collection, for I find £125 already deducted for this. It cannot be costs for distribution of gifts, for in the case of Smith, when there has been nothing distributed, the sundries are £4 2s. 2d. It cannot be deductions for income and land-tax, for they appear to be deducted before the items are placed to the income; and even if it be otherwise the income commissions allow this item. The distribution appears to be in the hands of the churchwardens, and that appears to be allowed for. Will the churchwarden please explain?

The muddled accounts of the churchwardens of St. Giles, Cripplegate, are only a specimen of the general state of charity accounts in the City of London, which, where not absolutely misapplied, are constantly wasted in creating paupers and supplying the demands of unworthy objects. In answer to demands for inquiry, we have an immense amount of frothy declamation on the virtues of local government and the evils of centralization, which have as much to do with the question as Goodwin Sands with Tenterden Steeple.

It is most unfortunate that so important a subject as the endowed schools should have been in the hands of such a man as Lord Lyttelton—honest and highly educated, but utterly devoid of the arts of conciliation which, to take an instance, Lord Granville wields with such signal success; obstinate, and, not to put too fine a point upon it, rude to deputations, who are often equally alarmed by the abnormal contortions of his countenance, and puzzled at an inarticulate speech which defies the most practised reporters. It is really sad to contemplate, on the one hand, the urgent needs of the City of London in the one direction, and the enormous sums annually absorbed by wasteful, ill-judged charity; by the salaries and perquisites of officials paid for doing nothing or for doing mischief; and, most of all, by those dinners, banquets, festivities, which occupy a weekly column of the *City Press*, at which the livery and other companies practise the virtue of hospitality by expending the funds of long deceased founders on asking each other to feed. Illustrious or remarkable persons are invited to adorn their feasts like the flowers, the pine-apples, and the plate borrowed for the occasion; but 90 per cent. of the feeders dine daily at their own expense in the City for a couple of shillings, or at home on a plain joint and pudding. In the meantime, St. Paul's requires for decoration, to make it worthy of its position, a quarter of a million; and the City School—an institution which ought to be peculiarly the object of the care of citizens—is starving for want of class-rooms and playground. The subject was very fairly discussed by the Court of Common Council. It seemed generally agreed that it was essential to provide a lavatory, a playground, and class-room accommodation, equal to any possible increase of the school; but the absurd point was, that in a City teeming with unused and misused charities, there should be any difficulty about the financial part of the subject. Two thousand pounds or twenty thousand pounds ought to be easily obtained from existing dormant charities. Here it is that the powers of a charity commission might be usefully worked. As for the few and paltry endowments of the City of London School, in scholarships and medals, they are truly disgraceful to a City where Livery Companies are continually spending hundreds on banquets. Already the action of the School Board has had an effect in stirring up the managers of the Ward Schools. These schools have, it seems, a funded property of between £50,000 and £60,000, an income of £2700 a year. They afford an indifferent education, exclusively confined to members of the Church of England, and offer a bribe of clothing to draw scholars; but the force of competition has originated committees of inquiry, discussion has followed, substantial reform is not far off. The very falling off of subscriptions, consequent on a school-rate, will cause a more close investigation of expenditure, and of results. One grand step has been taken in inviting Government inspection. Once again let us advise the trustees of City charities to put their houses in order, for the time is approaching when facts and figures will be required, and flatulent declamation will go for nothing.

The last of the direct examinations (which will in future be superseded by the college education) for appointments of engineers to the Indian public service has just been concluded. The examiner in engineering appointed by the Government was Mr. Wm. Pole, F.R.S. The examination-papers were made more comprehensive than on former occasions, and comprised, in the first place, the application of the sciences to various engineering problems; and, secondly, a series of questions to test the knowledge of the pupils in any practical branch of the profession, such as general construction, construction in iron, railways and railway locomotion, the steam-engine and machinery, water-works, and miscellaneous subjects, among which we noticed one relating to gas manufacture. It was understood that proficiency in any of these subjects would qualify. After a somewhat large number of the candidates had been rejected by the medical officers, thirty-five went up for examination at Burlington House; many of these were, we are informed, utterly incompetent; but fourteen were pronounced qualified in the engineering examination, seventeen in that for surveying, and eight in mathematics; only four, however, was found to coincide with marks enough to pass the whole, and consequently only this number of appointments were made, although there were twenty vacancies. The full number of marks were 1000, and 600 qualified; the highest number obtained was 654. This result does not give one a very high opinion of the present system of education for the engineering profession.

The report of the select committee on the Metropolis Water (No. 2) Bill will give a general satisfaction to the water companies, since it will leave them much as they were under the Act of 1852. The greatest change made is substituting the will of the metropolitan authority for the expressed wish of four-fifths of the inhabitants of a district. The will, however, of the municipal authority is not to be absolute, power being given to the companies to appeal to the Board of Trade. A more important saving proviso is the retention of the clause in the Act of 1852 which relieves a company from the obligation of giving a constant supply so long as more than one-fifth of the premises in a district are not supplied with the prescribed fittings.

Circular to Gas Companies.

The Municipal Corporations (Borough, &c., Funds) Bill has made no progress since the House was counted out on the 28th ult., and there is now no probability of its being passed this session. Mr. Leeman made an unsuccessful attempt to induce the Home Secretary to assist him in getting an early day for the consideration of the Bill; but there is an evident lukewarmness on the part of the promoters in pushing it forward through the remaining stages. Contemporaneously, but possibly in no other connexion, a report reaches us that the York Gas Company show a disposition to sell their undertaking to the Corporation of that city. The coincidence is curious; and supposing the practical withdrawal of the measure to be in any way connected with the circumstance just mentioned, it affords a clue to the not very creditable origin of the proposal. The chief supporters of the measure, it is hardly necessary to say, are borough members, urged on by their Town Councils, who seek to obtain power to squander the ratepayers money in pursuit of any object they may at the moment desire. Of the 33 members (tellers included) who voted for proceeding with the Bill at the division on the 28th, no fewer than 23 were representatives of boroughs.

We have so often urged the objections to this scandalous measure that it might now be left to the common sense of ratepayers. Still, it may be repeated once again, that the effect, if not the object of the Bill, is to encourage aggresion on private rights by public money, expended by irresponsible hands. Under the pretence of promoting the public interest, the governing bodies may assail every kind of private undertaking. They may bring forward, year after year, measures for the compulsory purchase of gas and water undertakings, or they may promote bills for starting competing works, and the ratepayers would be saddled with the costs; and seeing that gas and water companies are often the largest ratepayers in a district, they would be made to pay for their own persecution. We are here leaving Mr. Craufurd's proposed amendments out of consideration, and speaking of the Bill as it was returned to the House by the select committee. Much of the mischief the Bill is calculated to produce would be prevented if these amendments were carried. But we regard the Bill as shelved for this session, and before it can be reintroduced, the House of Commons will probably be asked to consider Sir Charles Adderley's Public Health and Local Government Bill, which is intended to carry out the suggestions of the Royal Sanitary Commission of last year. This Bill will make considerable alterations in the constitution of "governing bodies," and also enlarge their powers; and any such powers as the Municipal Corporations (Borough, &c., Funds) Bill will confer would be most properly bestowed in the former measure, if it were thought advisable to grant them at all. We hold that it is not advisable. We have said before that every measure which loosens the purse-strings of governing bodies tends to the promotion of jobbery and corruption; and that everything which unsettles the conditions of a commercial undertaking tends to the discouragement of private enterprise, to which we owe nearly every useful undertaking in the kingdom.

We publish to-day a first report to the Board of Trade by the metropolitan gas referees, on the construction of gas-burners with reference to the principles of gas illumination. The proceedings of the referees, we may remark, are altogether inexplicable. Last year they published a most unsatisfactory report on the "sulphur question," and all the gas world naturally looked for a second on the same subject this year, in which the difficulties and doubts raised in the previous one would be solved and settled. The "sulphur question" is one which intimately concerns them. With the construction of burners we do not know that they have any call to busy themselves. Most of the questions left open in the sulphur report could easily have been solved. A few hours, for instance, would have sufficed to decide whether or not sulphuretted hydrogen did really break up in the purifiers to form other sulphur compounds. The announcement last year of the discovery that such was the fact startled all gas manufacturers, and many others as well; and every one was looking for confirmation of the discovery, and some explanation of the phenomenon. Instead of this, however, we have a report on burners, and another on ammonia. The chief characteristic of the former is innocence. Starting with an introduction, which on the other side of the Atlantic would probably be styled "Buncombe," we are afterwards treated to a mass of elementary information respecting burners, and some points of physical science, which may possibly come with refreshing novelty "to the Lords of the Committee of Privy Council for Trade," but which are well known to every one having practical acquaintance with gas, and for the most part to every well-instructed schoolboy. Of the construction of burners we learn nothing in this report. All about them is to be told us in a second report, which is said to be in preparation, and the contents of which it is not difficut to guess. Whether we shall have to wait as long for this as for the second sulphur report remains to be seen.

It would be simply a waste of space to submit this document to any detailed criticism; there is, in fact, nothing to criticize. Beyond a few crude speculations, almost everything in the report has been put before the public over and over again, although not, it is true, in this verbose and pseudo-scientific-form. The substance of the report, stripped of its wordy disguise, might have been expressed in half a dozen sentences. Freed from all verbosity and confusion, the conclusions come to, so far as burners are concerned, are that the luminosity of a gas-flame depends upon the air supply, which in naked flames is regulated by the pressure at which the gas issues from the burner, and in Argands is controlled (in part, we would say) by the chimney. These facts are perfectly well known, if not fully understood, by every one conversant with the subject of gas-burners; but the principles involved have been but little applied in practice, and hence we have good burners and bad burners, the latter, unfortunately, predominating in number. It is the self-imposed duty of the referees to tell us how good burners are to be constructed, and when they have done so they will deserve the best thanks of all who did not know before.

We have said that there is nothing in the report which calls for criticism, but there are some remarks in the section on the effect of the air supply on the illuminating power which deserve a word of comment. The point sought to be established is that the luminosity of a flame depends, up to a certain point, on the rapidity of the combustion of the gas, and this is no doubt true. In other words, it depends on the heat of the flame, which, again, depends on the air supply. Take the upper white portion of gas-flames, which, as is here said, is the only portion of the flame which gives light. How is it composed? the referees ask. We will make a suggestion. There can be little doubt that the first step towards the production of light in a gas-flame is the "dissociation," by heat, of the elements of the hydrocarbons. When a flame smokes, the referees say that some portion of the gas passes through the flame without being perfectly consumed; and if they had said some portion of one element in the gas, they would have been quite correct. But gas is perfectly invisible. The smoke is solid carbon, and the explanation of a smoky flame is that the heat produced is not sufficient to raise the whole of the carbon particles to a state of incandescence. Put on a chimney and create a draught of air, and we produce the incandescence. Increase the height of the chimney, and so increase the draught, and we get more vivid incandescence—*i. e.*, more light. Increase it still more, and we have less and less light, until we arrive, in time, at the condition of the Bunsen burner, in which we probably have the instantaneous oxidation of the carbon with-

out any separation of it in a solid form to become incandescent. There is much in this part of the report which is quite beside the question at issue, and still more which betrays the innocence we have referred to.

The experiments on "the effect of the temperature of gas on "its illuminating power" have an interest, but we cannot consider them conclusive. When the experiments of the referees conflict with others, we cannot help waiting for some substantiation. As regards "the effects of distance from the gas-works on the illu- "minating power," we believe the Birmingham and Staffordshire Gas Company settled several years ago that gas would travel 13 miles without undergoing any deterioration, and therefore we are not astonished to learn that it will travel nine. In concluding, for the present, we must press on the referees the propriety of completing their investigations on the subject of burners at the earliest possible date, so that the multitude of bad burners at present in use may be quickly discarded.

We are sorry to see that any arrangement of the dispute between the Alliance Gas Company and the Dublin Corporation is as distant as ever. A large amount of correspondence has been published in the papers, and we believe the Dublin reading public are heartily sick of the subject. But the advisers of the Corporation still exhibit a wish to force upon the company a burner which is not the best suited to develop the luminiferous qualities of 20-candle gas, just as, in 1866, a burner was forced upon the company which was unsuited for 16-candle gas. The obstinacy of the Corporation in refusing to amend the Bill, by referring the matter to an umpire in case of disagreement between the referees, will render all the testing clauses completely nugatory. Each side, we presume, will put in a burner, and the Corporation may test with which they please; but it is clear that no prosecution for defect can be founded on tests made with a burner which has not been agreed to by the referees named in the Act.

A lamentable accident has occurred at the Wilmslow Gas-Works, resulting in the death of the manager and five others. The evidence given at the inquest shows that sufficient care had not been taken to support the sides of the excavation, and some thoughtlessness was exhibited, such as enormous weight of puddle so near the sides on such a soil. Another precaution which should always be taken under similar circumstances does not seem to have been adopted—viz., the draining of the sand by means of sumpts. Dry sand is much less likely to fall than wet.

It is reported that the three companies supplying the south of London with gas—the Phœnix, South Metropolitan, and Surrey Consumers—have agreed to amalgamate on the basis of the South Metropolitan being guaranteed their 10 per cent. on their present paid-up capital, and also on one-half of their uncalled-up capital of £200,000.

Parliamentary Intelligence.

HOUSE OF LORDS.

MONDAY, JULY 31, 1871.

The LIVERPOOL IMPROVEMENT AND WATER Bill received the Royal Assent.

The NEWRY BOROUGH IMPROVEMENT AND WATER SUPPLY Bill was read a third time, with the amendments, passed, and sent to the Commons.

THURSDAY, AUG. 3.

The ALLIANCE AND DUBLIN CONSUMERS GAS Bill, and the WATFORD GAS Bill, were returned from the Commons, with the amendments agreed to.

MONDAY, AUG. 7.

The BRIDGWATER WATER Bill, and the NEWRY BOROUGH IMPROVEMENT AND WATER SUPPLY Bill, were returned from the Commons, with the amendments agreed to.

THURSDAY, AUG. 10.

The METROPOLIS WATER Bill was brought from the Commons, and read a first time.

FRIDAY, AUG. 11.

A petition was presented against the METROPOLIS WATER Bill, from the Metropolitan Board of Works.

HOUSE OF COMMONS.

MONDAY, JULY 31, 1871.

A petition was presented against the MUNICIPAL CORPORATIONS (BOROUGH, &c., FUNDS) Bill, from the Dawley Gaslight Company.

TUESDAY, AUG. 1.

The ALLIANCE AND DUBLIN CONSUMERS GAS Bill, and the WATFORD GAS Bill.—The Lords amendments were agreed to.

A petition was presented against the MUNICIPAL CORPORATIONS (BOROUGH, &c., FUNDS) Bill, from the inhabitants of Halifax.

FRIDAY, AUG. 4.

The NEWRY BOROUGH IMPROVEMENT AND WATER SUPPLY Bill.—The Lords amendments were agreed to.

MONDAY, AUG. 7.

METROPOLIS WATER (NO. 2) (RECOMMITTED) BILL.

On the resolution for going into committee on the above bill,

Mr. W. H. SMITH moved that the order should be discharged, and that the bill should be recommitted to a select committee, and that the said committee should be instructed to inquire into the basis of the rateable value in existence at the time when the several water companies obtained the powers to rate occupiers of premises in the metropolis, as compared with the assessment under the Metropolitan Valuation Act; and that the committee report whether any, and if any what modification should be made in those powers, with a view to an equitable readjustment of the relations existing between the public and the water companies.

Mr. BRUCE said: At this late hour of the morning I should not have the face to proceed with such an important bill as the one now under discussion, although it was my intention this evening to have made some progress with it in deference to the wishes of the honourable members of the select committee; but, as I said before, at this hour of the morning it is impossible to give the measure the amount of consideration which it is entitled to receive. What I want to see is the bill and its amendments not only discussed in this House, but also out of it, in order that everything may be done to render it a good measure and facilitate its passing. I would propose to move, with the consent of the House, that progress be reported. With respect to the motion of the honourable member for Westminster, I do not wish to stand in the way of his making it; but I hope he will postpone it for this year. On the part of the Government, I may say that we should be disposed to facilitate anything the honourable gentleman might bring forward for the purpose of making the measure as nearly perfect as possible.

Mr. W. H. SMITH: After what has fallen from my right honourable friend, I will not proceed with the motion of which I have given notice, understanding that the Government will be prepared to support my proposal for a committee next year. With that assurance, I beg leave to withdraw my motion.

A petition was presented against the MUNICIPAL CORPORATIONS (BOROUGH, &c., FUNDS) Bill, from Whitby.

TUESDAY, AUG. 8.

METROPOLIS WATER (NO. 2) BILL.

The House went into committee on the Metropolis Water (No. 2) (Recommitted) Bill.

There were 58 amendments, of which notice had been given, but most of them were of a verbal character.

Clause 8 provided that when application has been made to any company requiring such company to provide a constant supply, or when any company has given notice to a metropolitan authority of a proposal to give a constant supply in any district, it shall be lawful for the company so required, or for the metropolitan authority upon whom notice of such authority has been served, to present a memorial to the Board of Trade, setting forth their objections, if any, to such requisition or proposal, and shall transmit a copy of such memorial to the other party. The Board of Trade is required, as soon as conveniently may be after the receipt of such memorial, to take the same into consideration, and may institute any inquiry in relation thereto.

Dr. BREWER moved the omission of the clause, and he hoped the Government would not be adverse to the amendment he proposed. He thought the House would agree with him that the Board of Works had done enough to forfeit the esteem and regard of the country. He would divide the House on the subject.

The question was then put that the clause stand part of the bill, and Dr. BREWER, in a loud voice and amid some laughter, said "Aye."

The CHAIRMAN therefore said that the clause was passed.

Dr. BREWER said he had challenged the opinion of the House on the subject.

The CHAIRMAN said that when he put the question, Dr. Brewer had assented to the clause.

The clause therefore stood part of the bill.

Clause 9 provided that no company should be compelled to give a constant supply to any premises in any district, until the regulations provided for by the Act are made and are in operation within such district, nor so long as it can be shown by such company that more than one-fifth of the premises in such district are not provided with the prescribed fittings.

Mr. ADOLPHUS YOUNG said that as the clause was framed, the metropolitan board must give notice to the water companies, and if one-fifth of the whole of the houses in the district were not provided with fittings, the obligation to supply the water was not applicable. He wished the clause to be quite clear, and thought the Board of Works or the metropolitan authority should have some notion, before giving notice to the public, that the district was not in a fit state for a supply. The obligation thrown on the companies by the Act was a very great one. He therefore moved the insertion of words limiting the force of a requisition against a company for a constant supply to one month.

Sir M. BEACH asked the precise force of the words intended to be inserted.

Mr. WINTERBOTHAM explained that by the bill the metropolitan authority, whenever they were of opinion that there should be in any district a constant supply, make application to the company within the water limits in which such district was situated, requiring a constant supply. But no company was to be compelled to give a constant supply to any premises until certain conditions had been fulfilled, nor so long as it could be shown by the company that one-fifth of the premises in the district are not provided with the prescribed fittings. The requisition by the metropolitan authority had thus a permanent force, and the object of the amendment was to limit its force to one month after service, so that it would not be kept suspended over the heads of companies until the requisite number of fittings were provided. The only effect of the amendment was that, after the expiry of one requisition, another would require to be served on the company before the company was to be bound to give the supply.

The clause was amended accordingly.

Mr. STAPLETON moved the insertion of the following proviso in clause 9:—"Provided nevertheless that from and after the passing of this Act every company shall, on Sundays as well as other days, supply sufficient pure and wholesome water for the domestic use of the inhabitants within their water limits; and in case any company shall fail or neglect to deliver such supply, such company shall incur a penalty not exceeding £200 for every day of such default."

The amendment was agreed to, and the clause was amended accordingly.

The 9th clause also provided that in any district in which a default by a company in giving a constant supply has been shown, the "metropolitan authority may," by notice in writing, require the owner or occupier of any such premises, within a time to be specified in such notice, to provide the prescribed fittings, or to cause the fittings in such premises to be repaired.

Dr. BREWER moved as an amendment, that in place of the words above quoted, the words "company shall" be inserted. He said the water-fittings were for the protection of the company, and it was more convenient that they should see that the proper regulations were attended to.

Mr. CAWLEY hoped the committee would not agree to this amendment. The point implied in it had been investigated by the committee upstairs, and they were of opinion that it would not do to throw the burden on the companies.

Mr. BRUCE hoped the committee would stand by the clause.

The amendment was negatived without a division.

Clause 13, which related to the supply of water in courts, passages, &c., provided that if at any time it appeared to the Board of Trade, on the report of the nuisance authority, as defined by the Sanitary Act, 1866, that a constant supply cannot be well and effectually provided for that group or number of dwelling-houses, except by means of a third pipe or other apparatus placed outside the dwelling-houses, the Board of Trade may from time to time make an order to the effect that such group or number of dwelling-houses may be so supplied, and shall serve the same on the company within whose water limits the dwelling-houses are situated.

Dr. BREWER moved an amendment to the effect that the order referred to should emanate not from "the Board of Trade, on the report of the nuisance authority," but from the "metropolitan authority," of its own motive, and with-

out a report from any nuisance authority. He said there were no fewer than 37 nuisance authorities within the metropolitan district, and it was therefore very desirable to have one authority, acting independently, empowered to make the order contained in the clause.

Mr. CAWLEY, referring to the object of the clause, which was to enable provision to be made for the supply of water in courts, by means of stand-pipes, said that it had seemed to the committee upstairs, as it had done to himself, that the nuisance authorities were the only parties who ought to have authority over this matter. A great deal of evidence bearing on that question would be taken, and such was the result of their deliberations.

Mr. BRUCE said, if he recollected right, the nuisance authorities were the vestries. It seemed to him that it would make the clause more stringent if the metropolitan authority were substituted for the Board of Trade, acting on the report of the nuisance authority.

Sir M. BEACH thought there would be an objection to the Board of Trade, on the ground that it was the umpire between the metropolitan authority and the water companies.

Dr. BREWER said it would be impossible to work the Act with the clause as it stood, if there were not some authority to take the initiative.

Sir J. C. LAURENCE urged that the effect would be very different from what was supposed by the honourable member who moved the amendment, because the power of the nuisance authority, as a nuisance authority, would still remain.

Dr. BREWER: No, it would not.

Sir J. C. LAURENCE replied that the local board had always exercised sanitary power, and it was for them to make the report.

The question was put, that the clause stand part of the bill, and the CHAIRMAN declared that the "Ayes" had it.

Dr. BREWER challenged the result.

Several MEMBERS: Do you wish to divide the House?

Dr. BREWER: Yes; they cannot work the Act.

Dr. Brewer thereupon left his seat to speak to the Home Secretary, and the question was again put in the usual form, with a view to a division, that the clause stand part of the bill, Dr. Brewer not dissenting, amid laughter and cries of "Oh, oh!"

The same clause (13) also provided that, "If the requisite stand-pipe or other apparatus, in accordance with the regulations of the company, is provided, then the company shall give to those dwelling-houses a supply accordingly, by means of the stand-pipe or other apparatus so provided."

Mr. CLAY moved the addition of the following words:—"And, on giving such supply, to receive and recover water-rates or rents from the owners or occupiers of such dwelling-houses as if the supply had been given in the premises."

Mr. CAWLEY said an amendment on the same subject had been proposed to the committee upstairs, but it went much further than the present one. He did not know that the words now proposed would make any real difference, and they would certainly do no harm.

The amendment was accepted, and the clause was amended accordingly.

Dr. BREWER moved the following addition to the same clause—"The expense of providing such stand-pipe or other apparatus shall be borne by the owner of the dwelling-houses, or if there is more than one owner, then by the respective owners, in such proportions as the metropolitan authority shall direct."

Sir M. BEACH did not see any use in these words, especially as a preceding clause of the bill contained a provision by which the metropolitan authority was empowered to require the owner or occupier of premises to provide or repair fittings.

The amendment was negatived without a division.

Clause 15 provided that any company which violated, refused, or neglected to comply with any of the preceding provisions of the Act should be liable to a penalty not exceeding £200, and to a further penalty not exceeding £100 for every month during which such violation or refusal or neglect to comply with the said provision continues after they shall have received notice in writing from the Board of Trade to discontinue such violation, refusal, or neglect.

Dr. BREWER thought the penalty quite insufficient, and moved, as an amendment, that the penalty, instead of being £100 for every month, should be £50 for every day.

The amendment was negatived without a division.

Clause 16 provided that "every company" shall, within six months after the passing of the Act, make regulations for the purposes for which regulations may be made under the authority of the 26th section of the Metropolis Water Act, 1852.

Dr. BREWER moved an amendment to the effect that the authority which should frame the regulations should be the metropolitan authority, as there were eight companies in London; and it was quite clear that, if eight companies were each allowed to make regulations, there would be great disparity in the regulations.

Mr. CAWLEY thought no case existed in which the initiative was given to any other power but the companies. The circumstances of each water limit might differ, in which case it would be absolutely necessary to have different regulations.

The amendment was negatived.

On clause 20, which provided that notice of any regulations formed by the water company shall be served on the metropolitan authority within four days after the making of any regulation, or of any repeal or alteration in any regulation,

Dr. BREWER moved that the time should be ten days instead of four, but the amendment was negatived without a division.

Clause 33 contained a series of provisions relating to fire-plugs.

Mr. CAWLEY, on the clause being put, remarked that the state of the fire-plugs in London was a disgrace to any town whatever.

Dr. BREWER said the clause threw the burden of providing plugs on the Metropolitan Board of Works, but they had no means to devote to that purpose. Give them the means and they would supply the fire-plugs.

The clause stood part of the bill.

Clause 38 provided that "the auditor shall, with all practicable speed after the passing of this act, investigate the accounts of the companies, and ascertain and certify the amounts of their capitals, distinguishing share from loan capital, and shall ascertain and notify the capital of each company, and shall from time to time, as new capital shall be expended, in like manner ascertain and certify the amount of such new capital that has been *bonâ fide* expended for the purposes of the undertaking. Notwithstanding anything in this Act, the auditor shall not investigate the accounts of any company antecedent to the date mentioned in that behalf in relation to such company in the schedule C to this Act annexed."

The schedule referred to in the clause fixed the following dates for the respective companies antecedent to which the accounts of such companies shall not be investigated:—

New River Company	July 16, 1866.
East London Water-Works	July 15, 1867.
Southwark and Vauxhall Company	April 12, 1867.
West Middlesex	May 13, 1869.
Lambeth Company	May 13, 1869.
Chelsea Company	June 3, 1864.
Grand Junction Water-Works	May 29, 1868.
Kent Water-Works	June 30, 1864.

Dr. BREWER moved the omission of all the words of the clause subsequent to the word "undertaking."

Mr. CAWLEY said that the effect of this would be that the accounts would be overhauled.

Dr. BREWER thought that an investigation into the capital was required in the interests of the public, who were entitled to a diminution when the dividend was 10 per cent. The investigation should not be limited as to date to the last special Act of the company, as many of these Acts had been opposed, and there had been no examination whatever.

Mr. WINTERBOTHAM held there should be some limit as to date.

The committee divided on the amendment, and the numbers were—

Against the amendment	41
For the amendment	5
Against the amendment	36

Dr. BREWER moved the omission of clause 50, which threw the costs of the Act on the Mayor, Aldermen, and Commons of the City of London, and the Metropolitan Board of Works, in such proportions and to whom the Board of Trade shall direct. He said it was a very unfair clause, the bill being one for the purpose of regulating the water supply. The metropolis had not moved for this bill; they were merely submitting to it. They were promoters in no way.

Mr. BRUCE said the object of the bill was to compel companies to do certain things for the benefit of the ratepayers.

Dr. BREWER: They do not consider it to be a benefit at all, but a great injury.

The amendment was negatived without a division. The various other amendments were then gone over, and the bill passed through committee.

WEDNESDAY, AUG. 9.

METROPOLIS WATER BILL.

On the consideration of this bill as amended,

Mr. WINTERBOTHAM stated that in passing this bill through committee yesterday one or two amendments had been overlooked. On his motion a proviso was added to clauses 9 and 28, to the effect that nothing contained in the bill should affect any contract made between the owner and the occupier respecting the payment of the expenses of providing or repairing fittings.

Clause 33 provided that the expense of providing fire-plugs by a company shall be provided by the Metropolitan Board of Works.

Mr. WINTERBOTHAM moved that the words "out of their general revenue" be added to the clause, lest the metropolitan authority should not otherwise have sufficient funds to meet the cost of the plugs.

The amendment was agreed to.

The bill was then read a third time, and passed.

HOUSE OF COMMONS.

(*Before Viscount* BURY, *Chairman; Mr.* WATERHOUSE, *Colonel* STUART, *and Sir* JAMES STRONG.)

EDINBURGH AND DISTRICT WATER BILL.

THURSDAY, APRIL 27.

Dr. *H. D. Littlejohn* recalled, and cross-examined by Mr. WILL.

I have no fault to find with the quality of the water at present supplied to Edinburgh. I have never had any complaints of its quality except in dry seasons, when it becomes impure owing to the sides of the artificial reservoir becoming disintegrated in consequence of the action of the sun and air. I have not been consulted as to the expediency of doing away with the existing supply. The St. Mary's Loch water is better than the water we get at present. It is softer, and there is a greater quantity. I found the Heriot water peaty. It had been raining just immediately before my visit. St. Mary's Loch in part is in a mossy and peaty district. It is a large central loch, with several tributaries running through it. Any stream tinted with peaty matter that flows into the loch deposits the peaty matter there, but that matter subsides. I have no doubt the bottom of the loch is covered with peaty matter. When I was there a high wind was blowing, but the peat remained undisturbed. I have seen the pebbly bottom of the lake quite plainly at some places where the water must have been more than 2 feet deep. I am aware Dr. Frankland stated that he had to strain off the fleas, but I did not see any when I examined the loch. Dr. Alexander Wood was employed to write reports in answer to the letters of "A Physician." I do not agree with Dr. Wood that the spring water of the Heriot and of the Talla is superior to the water of St. Mary's Loch. It might be if St. Mary's Loch were merely a stagnant or artificial lake, but not as it is, a natural lake, with water which is always flowing. The present supply to Edinburgh is from 25 to 30 gallons per day per head. I should not like to have less than the Glasgow supply of 50 gallons. I cannot give another instance besides Glasgow. English towns differ so remarkably from Scotch towns in their sanitary arrangements, and cannot be compared. I have not heard that a greater supply is necessary for a Scotch town than for an English town. The action of water upon lead makes it injurious for domestic purposes when the softness reaches a certain degree of purity. The water of St. Mary's Loch has a hardness of about one and a half, and that is enough to secure the inhabitants from injury in consequence of its coming into contact with leaden pipes. The death-rate of Glasgow is greater now than it was previous to the Loch Katrine supply. It would have been larger had there not been a plentiful water supply.

Mr. WILL: You told us yesterday that a great deal had been said about Dr. Letheby's reports, who speaks of the rate of mortality *quoad* the degree of hardness of the water used by the people, and you said that a better explanation was to be found in the density of the populations. Now, I have a table here, made up by Dr. Letheby, and I wish to know if it coincides with the results of your examinations. I find that in the five towns—London, Birmingham, Nottingham, Hull, and Sunderland—the water used is of 10° of hardness, the number of persons is 40 per acre, but the average death-rate is 22 per 1000.

Witness: I object to the lumping of the towns together, and giving the population and acreage. We ought to have each town separately and each part of the town.

Mr. WILL: The figures are from the Registrar-General's weekly return. They are official figures.

The CHAIRMAN: I think the answer of the witness is almost sufficient. You can hardly press the point any further.

Mr. WILL: You told us that you attributed the death-rate in Edinbugh in a great measure to overcrowding. Is it a fact that overcrowding is a great nuisance there?

Witness: It is. The death-rate in Edinburgh is 25 in the 1000.

Mr. WILL: Do you say that that is an extensive death-rate?

Witness: It is, most decidedly.

Mr. WILL: I see that the Registrar-General's return for the week ending the 28th of January last shows that the average number of deaths in the nine large towns was 29 per 1000. In London it is 26 per 1000; in Nottingham and Bristol, 30; in Liverpool, 46; in Manchester, 29; in Salford, 22; in Bradford, 27; in Sheffield and in Sunderland, 31; so that Edinburgh has a lesser rate of mortality than any of those towns except Salford?

Witness: Yes; but there is nothing so fallacious as the returns of the Registrar-General. The average death-rate of Edinburgh is 25 per 1000, but all parts of the town are lumped together, whereas it is a matter of fact in the worst parts of the town the death-rate rises up to 40 in the 1000.

Mr. WILL: But that objection will apply to the returns of every town.

Witness: Yes; but Edinburgh is peculiar in having an enormous poor population living together very densely.

Cross-examination continued: Selkirk is a thriving place. It is dependent for its prosperity upon the water power which supplies its manufactories, and it is highly desirable that the water should be protected and maintained.

By Mr. MACDONALD: I think some parts of Edinburgh require a larger supply of water than is necessary for an ordinary town. A supply of 50 gallons

per head all over might meet the difficulty, but of this I am not certain. The improvements being carried out in the Old Town are very extensive. When they are completed they will have a beneficial effect upon the sanitary condition of the town. They will give us more air, and there will be less tendency to accumulate filth. I am opinion that the closes ought to be flushed twice a day. I should like to see them abolished altogether. Our efforts for the amelioration of the condition of the inhabitants will be fruitless without a sufficient supply of water. Until that supply is obtained, the other improvements cannot be carried out. When they are carried out, the necessity for such an enormous supply will not be so great in some places.

By Mr. MUNDELL: In the worst parts of Edinburgh the death-rate is about 40 in 1000. I should say it is quite as high in the worst districts of Glasgow. It is quite possible that our death-rate might remain the same if we had an abundant supply of water. Therefore I do not think an increased water supply necessary as a panacea, but only as one of the elements of health. The deposit of refuse placed nightly and every morning in Edinburgh on the streets necessitates an enormous amount of surface cleaning, which cannot be managed without an abundant supply of water. The scavenger in hot weather drops the refuse into all the interstices between the stones, and when that occurs the air is tainted. The demand for water in Edinburgh for manufacturing purposes is comparatively small. We have experienced a dearth of water ever since 1854. I believe the people have been starving for water every summer, with one or two exceptions, when we had wet summers.

Re-examined by Mr. CALVERT: The plan of the water company was to go to Moorfoot. I think there ought to be a supply of water in every room on a flat. About a year ago I presented a report to the Town Council as to the sanitary condition of 800 families in the neighbourhood of the council chambers. There was no water, and no means of carrying off the dirty water, and the consequence was that a high rate of mortality was to be expected. The new houses require a larger supply of water than the old ones, because they are adapted for baths and water-closets. I decidedly prefer a natural to an artificial loch as a source of supply to a town, and I should prefer a loch through which tributaries are constantly flowing. Were St. Mary's Loch a stagnant loch, I would not have it on any account.

Dr. *Alexander Wood*, examined by Mr. CLERK.

I am a Fellow of the Royal College of Physicians at Edinburgh, and have been thrice elected president. I am also chairman of the Association for Improving the Condition of the Poor in Edinburgh. For several years I have paid great attention to the question of water supply. The late Sir James Y. Simpson and I conducted inquiries on the subject, in order that we might have actual facts to submit to the committee of the House of Lords in 1869. Both of us gave evidence before that committee as to the flagrant deficiency of water in Edinburgh, and Sir James Simpson said he wondered the sufferings of the people from this circumstance did not cause a rebellion. Judging from the analyses, the St. Mary's Loch water is well qualified for the domestic supply of a city like Edinburgh; it is particularly well adapted for cooking purposes, and fairly adapted for drinking purposes. Some waters which are exceedingly injurious are more palatable than a wholesome water. I do not think the water of St. Mary's Loch will be quite so pleasant to the taste as water which might not be so good for the constitution. The presence of carbonic acid makes the water more sparkling and pleasant to drink. Water issuing directly from a spring is generally cool and more brilliant than water taken from a flowing stream. When water has been standing for some time in a lake or reservoir, it always parts with a certain proportion of carbonic acid gas. In all waters supplied from reservoirs there must always be a certain accumulation of vegetable matter. As regards the quality, it makes very little difference whether the water is drawn from a natural or an artificial lake. Inasmuch as in an artificial lake there is not a natural pebbly beach, and both sides may be abraided by the action of the wind, the quality of the water from a natural lake may be better than that from an artificial lake. There has been an attempt to excite the inhabitants of Edinburgh by the assertion that there would be less consistency in their bones if they drank that water, because they say there is not enough lime in it to supply the bones of the body; but I consider the objection to be simply ridiculous. Of course the introduction of lime into the human body is essential for the purpose of keping the organization healthy. There is more lime in a plate of porridge, which is the common food of the poorer classes in Scotland, than in any quantity of water. Almost all vegetable substances contain a sufficient quantity of lime to support the human system. Whoever the gentleman signing himself "A Physician" may be, he has no knowledge of medicine, and I will give my reasons for this statement. He says that rickets, the essence of which is softening of the bones, may be produced by the absence of lime in the water drunk by a person suffering from the disease; but those who know anything about the matter are aware that lime is actually in excess, and that, instead of going to the formation of bone, it is excreted by the kidneys, and goes to the bladder. St. Mary's Loch contains lime —more, in fact, than Loch Katrine. There are whole districts in the Scotch mountains composed of rocks of the primary formation, where the water contains no lime whatever. The inhabitants of these districts are by no means of a gelatinous nature. For all washing purposes a small quantity of lime is a very great advantage. A certain quantity of soap must neutralize the lime before it is used for detergent purposes. It has been a great problem to soften hard waters to enable them to be used to greater advantage. This has been done by adding salts of soda, which the householders do not much like. It was found that this process tended to injure the fabric of linen and cotton, and to destroy the colour. For all manufacturing purposes, except for the brewing of bitter ale, soft water is preferable to hard water. I never saw a lake free from water insects. These animals live on that which accumulates in water, either naturally or artificially stored, and it is for the advantage of the water that they should remove certain of the matters which are in it. I was glad to see these animals were so large, because the larger they are the more easily they are removed by filtration. If you examine filtered water with a microscope, you will find a large quantity of small insects that cannot be removed by filtration. I have seen insects in the present supply to Edinburgh, and in other reservoirs also. There are various water insects. There is the water spider, which is about the size of a split pea.

Cross-examined by Mr. WILL: The company were bound under their Acts to filter the water after it leaves the reservoirs, but it has been a standing complaint against them that the water was not properly filtered. I was not aware that the water proposed to be taken from St. Mary's Loch would be delivered without filtration. I should certainly filter the water myself, or have it filtered, before using it. I do not know, however, that St. Mary's Loch water requires more filtration than any other. With regard to the question of hard and soft water, I adhere to what I wrote in my reports, and I agree with the report of the Duke of Richmond's commission as to the advisability of procuring water containing a moderate quantity only of carbonate of lime, a considerable portion of what is required being conveyed into the system by means of the food taken.

Dr. *Stevenson Macadam*, examined by Mr. CLERK.

I am a lecturer on chemistry in the Edinburgh University School, Fellow of the Royal Society of Edinburgh, and of the Chemical Society of London, and for twenty years I have had great experience in the analysis of water. I have been consulted with regard to the supply of water for a large number of places in Scotland and England, and even with regard to places in South America, and I was recently consulted with regard to a supply of water for Jerusalem. In August, 1868, two bottles were submitted to me for analysis. I did not know whence the water came when I made the analysis. In my report I stated that "the waters were clear and transparent, free from visible contamination, and possessed an agreeable taste. When seen in bulk a faint yellow tinge was observable. On analysis of each water the following results were obtained, calculated to one imperial gallon :—

	No. 1. Grains.		No. 2. Grains.
Saline matter, principally carbonate of lime (chalk), sulphate of lime (stucco), and chloride of sodium (common salt)	2·27	..	3·21
Organic matter of vegetable origin	0·61	..	0·63
Total salic and organic matter dissolved in imperial gallon	2·88	..	3·84
Hardness	1¼°	..	2°

The waters were of an agreeable character, and of excellent quality for general and domestic use," &c. I have since found that the contents of one bottle came from the Loch of the Lowes, and the other from St. Mary's Loch. On the 14th of January, 1871, I reported upon the St. Mary's Loch scheme that the water was suitable for domestic purposes, and I am still of the same opinion. I think a most important fact in favour of the St. Mary's Loch scheme is, that owing to the great height and peculiarly pastoral character of the watershed, the quality of the water is not likely in the future to be deteriorated by the results of cultivation of the land. These fleas are always found in impounded water. I have here [producing a bottle] a specimen of water taken from one of the reservoirs which now supply Edinburgh with water, in which after standing a fortnight in my laboratory fleas were developed. They can be seen easily with the naked eye, being about as large as pins heads. [The bottle was handed to the committee.] I believe that if the spring water were carried into Edinburgh by pipes, and delivered to our cisterns without being exposed to the air, as part of it undoubtedly is, that you would not find at first any water fleas in the water. But I know this, that if you allow such water to remain in the cisterns, the water fleas will show themselves, and I know also that a good deal of the spring water at present conveyed into Edinburgh is, whilst resting in the two existing reservoirs, exposed to atmospheric influences; and I have observed in previous years the water fleas in these reservoirs—reservoirs supposed to have in them spring water for the supply of Edinburgh.

By the COMMITTEE: I do not think a full draught of that water would have any deleterious effect. I place these animals very much in the same category that I would place the small insects to be found upon a strawberry or a gooseberry. We know, especially in regard to raspberries, that you have a great many little animal organisms adhering to each berry, and yet we partake of raspberries without being in the slightest degree the worse for it. In my report, speaking of these animalculæ, I said: "They are to be found more or less in all soft water, including the less quickly running part of streams, and any water—whatever be its source or quality—if stored up in natural or artificial reservoirs, is certain to exhibit evidence of their presence." I also referred to the water I had observed in the reservoirs at the Pentland Hills, which are actually fed with spring water, and stated that I found those fleas in the said water drawn from the cistern in my house at Portobello; that these fleas are found in the best and most wholesome water, and that they are not indicative of any impurity or contamination of the water. I then go on to say: "I believe them to be quite innocuous, as they are separated from the water by mechanical filtration. The mere passage of the liquor through a bed of sand or gravel is sufficient to remove them." Supposing I had a well-developed animalculæ, filtration would remove it; but suppose I had the germ only, it would be developed in the cistern in a day or two. I know that these water fleas are developed in our cisterns, and I presume that the germs must come from the reservoirs. As to the question of filtration removing the germ, I have not made any special inquiry into the subject. I further state, in my report, that when science has taught us the organic nature of much of the dust that floats in towns, and that we could not breath the air contained in our own rooms without inhaling some of this dust, there should be no cause for distrust and alarm in the knowledge that the best water, when impounded during the summer months, is liable to contain a few minute atoms of animal life, which are as harmless as the animal organisms adhering to every strawberry or raspberry that we partake of. I enter into the question of the amount of saline matter, including lime-salts, and state that the question of the amount of saline matter, including lime-salts, perceived in the water of St. Mary's Loch has been discussed lately as if it were simply a medical point, whereas it is a chemical one; that no wholesome natural water contains beyond a trace of the phosphate of lime; that the hardest water owes the property of hardness to the presence of sulphate of lime or calcareous bone; and that a tumbler of milk or beer will contain more lime suitable for bone supply than the drinking of an entire gallon of any hard water. I must state that the only water in which I found anything like true bone matter in any quantity was water which had its origin in the neighbourhood of churchyards, which led to the production of phosphate of lime in solution, and that passed to the springs in the neighbourhood. But I do not think that even physicians would regard the water which had percolated through the remains of our ancestors as a water which was wholesome. I found such water impregnated with animal matter, and highly impregnated with phosphate of lime. The water of St. Mary's Loch has already four grains of saline matter in solution, and the passage of the water through built conduits for a part of the way in its transit to the city will doubtless supply a couple of grains more. I believe it contains quite as much saline matter as is necessary to make it palatable, and we know that for cooking and washing purposes a soft water is greatly to be prized. I have reported upon the water of St. Mary's Loch as fit for domestic use. I had a number of specimens of the water collected on the 17th of February last. All the samples were shown to Professor Christison and Professor Maclagan, and we made preliminary tests as to quality in the presence of each other. My report was made on the 15th of March. The water was selected under circumstances which were as unfavourable as possible. I took samples from the foot of St. Mary's Loch, the middle, the top, and from the upper and lower parts of the Lowes, from springs, and from the Yarrow, at some distance from St. Mary's Loch. They were clear, transparent, and practically free from sedimentary matters. They evolved no odour, and were of an agreeable taste. The water from the spring contained a little more saline matter than the other samples. There was a little organic vegetable matter, but not of a deleterious character. The water is favourable for all domestic purposes, being of two degrees of hardness, but would be unsuitable for brewing purposes. In the water taken from the loch there were some particles of organic matter held in suspension, owing to the fact that there had been a fall of snow, and the loch was running full. The water of the streamlets closely resembled that of the lochs, but that of the Yarrow was slightly tinged with colour arising from peaty matter. I am decidedly of opinion that the water of St. Mary's Loch is of excellent quality for town consumption, is thoroughly aërated, and perfectly safe to use for all domestic and manufacturing purposes. I have tested the water, and find that it can be carried through lead pipes without producing any poisonous or injurious effects. The samples were collected at a period of the year and under circumstances when the water must be in its worst condition. As to animal life, not the faintest evidence of water fleas or other minute organisms could be observed at this season of the year; and in this respect the water of the loch agrees with our present supply, which is equally devoid of animal organisms. In the winter, jointly with Professor Christison and Dr. Maclagan, I made tests of the quality of the water. On the 3rd of April I again inspected the water, and collected fresh samples, which were again analyzed, with the same result. On the 15th of April I took other samples, which are contained in the hamper

produced. In every instance the tests showed that the water was fit for domestic use. I analyzed also the water of the Heriot district. It is one of the tributaries of the Gala stream, which is more used than any other stream in Scotland for manufacturing purposes. The result was about the same as that of St. Mary's Loch, but the loch water is a little harder, that of the Heriot being four degrees of hardness. On several occasions every year I have been in the habit of visiting the Heriot district, and am enabled to say that, in the course of time, it is probable that the land in that district is more likely, year by year, to be appropriated for agricultural purposes than the land in the neighbourhood of St. Mary's Loch. On the 3rd of April I sent samples of the waters collected from the Talla, Heriot, and St. Mary's Loch to Dr. Frankland. The samples were collected on the 1st and 3rd of April, and were sent to London on the same day. The specimens from the Talla and Heriot submitted to Dr. Frankland were taken after a rainy season; but, considering the agricultural operations going on in the district, a certain portion of the manures used on the land would be carried into the reservoir if it were impounded. It would be likely to be much more contaminated by manurial matters than the water of St. Mary's Loch.

Cross-examined by Mr. RODWELL: The Heriot district is pastural and the soil is sandy, with a porous subsoil which, to a certain extent, acts as a filter; but the mere question of the ground being of an open nature does not remove the impurities when they once find their way into the soil. For instance, we had some time ago a serious outbreak of cholera, which arose from the fact that the wells had become contaminated by impurities contained in the existing land. Having mingled a great deal with farmers, I know the character of their operations, and of the substances they use. I know, also, from the enterprise of Scottish farmers, that no considerable length of time will elapse before the land in the Talla district gets broken up for agricultural purposes. [Witness produced samples from the lochs, from the Megget stream, and other sources—collected by himself, Dr. Littlejohn, and Professor Maclagan.] One sample taken from the St. Mary's Loch water shows 2·27 grains of saline matter; it was taken, I believe, from the Lowes. Another sample, taken from the foot of St. Mary's Loch, shows 3·51 grains of saline matter; that is the water which would be used. I find that in 1868, before any question arose as to this water being taken for the supply of Edinburgh, I reported that the water was clear and transparent, free from visible contamination, and possessed an agreeable taste. Both waters are practically the same, and may be regarded as equally suitable as a beverage and for culinary purposes. I would recommend to the trustees that on the introduction of such water as that of St. Mary's Loch there is no necessity for filtration, but considering the unnecessary alarm created by wild statements in opposition to this scheme, it may be desirable that a filter should be constructed in order to allay such fears. I believe that very absurd stories have been circulated about the water fleas. St. Mary's Loch is the finest loch in the Lowlands of Scotland, and there is no reason why there should be fleas there any more than in any other loch in Scotland. There is no accumulation of organic matter—nothing to breed these animals; and it is one of the finest pastoral districts we have. It is really absurd to say that you have more water fleas in St. Mary's Loch than in any other loch in Scotland. The test I generally use in determining whether water will act upon lead is to place the water in a small cistern, and let it remain for 24 hours. I did so in this case, and the result was that the action of the water on the lead was less than with the present supply to the city. I tried another experiment, and found that there was not the slightest discoloration by the action of the lead. I say decidedly that there were no properties in the water which would act on the lead.

Mr. RODWELL: Are there burns near the loch in which the water is as brown as porter?

Witness: Not one. I have gone round the loch repeatedly, and in all weathers, and I never saw any water of the colour you describe.

Mr. RODWELL: Did you see any of a light brown colour?

Witness: I have seen one with a faint yellow tinge, but very slight.

By Mr. MACDONALD: The watershed of St. Mary's Loch drains slowly. The water used at Galashiels for scouring purposes in the making of tweeds is not taken from wells. It may be collected in cisterns, but the greater proportion is taken from the Talla. I know the wells in Galashiels are in a bad condition. I do not know whether the land at Selkirk is cultivated above the Ordnance datum. In the Hope district there is a great deal of ground brought under cultivation. St. Mary's Loch is considerably above the Ordnance datum, and there is no great extent of land there which could be brought under cultivation. In the Heriot district cultivation is carried as high. When cultivation is carried very high, it would have an effect on the water by manure pollution.

Re-examined by Mr. CLERK: At St. Mary's Loch the hills are steep, and the land does not admit of cultivation. The Moorfoot Hills, on the contrary, have broad tops. I know the property of Mr. Pringle at the head of the Heriot, and a good deal of it has been broken up for growing crops, and the same thing is likely to continue. I have found animalculæ in the present reservoirs which supply Edinburgh. The Heriot waters would be liable to become more or less stagnant by impounding, whereas, in the case of St. Mary's Loch, the flow of water is so great that there would always be fresh water passing through the loch, not only towards Edinburgh, but down the river.

Mr. *Robert Mitchell*, examined by Mr. CALVERT.

I have resided all my life in the neighbourhood of St. Mary's Loch. I have examined all the feeders of the loch, which derive their water principally from springs. The springs are pure and clear, though in time of rain some of them are a little discoloured. According to my experience, St. Mary's Loch water is very good for drinking. It is used for all purposes by the inhabitants on the margin of the lake. I never heard any complaint about the quality of the water until some people of Edinburgh began to talk about it. Judging from the longevity of the people, it is quite wholesome. I never saw any fleas during wet weather. I have found St. Mary's Loch slightly discoloured, but after a day or two it was again quite pure and clear. There have been a few sheep dipped in the burn.

Cross-examined by Mr. WILL: The sheep are dipped in a certain solution before going into the water. I believe arsenic is occasionally used, but not generally. We use M'Dougall's dip, which contains a good deal of paraffin oil. In 1859 a great many sheep died in the neighbourhood of St. Mary's Loch, including lambs—the number might be 5000. I do not know that any of the carcases were thrown into St. Mary's Loch or its feeders. I believe part were buried and part taken home to feed the pigs. In justice to the shepherds I must state that they are not in the habit of throwing dead sheep into the loch or any of its feeders.

By Mr. MACDONALD: There is a good deal of peat on the top of the hills. The loch contains a considerable number of springs. The flood of the Yarrow takes longer to rise than that of the Ettrick, and falls slower.

Mr. *Robert Laidlaw*, examined by Mr. CALVERT.

I am the tenant of the farms of Surdhope and Bowerhope, situated near St. Mary's Loch. I have resided for 47 years at Bowerhope, and never heard of people in the neighbourhood being unwilling to drink the water of the loch. Within the last month or two I have heard complaints about it from Edinburgh. I never saw a flea in the water.

Cross-examined by Mr. WILL: I had charge of the sluices in St. Mary's Loch that the Selkirk people have had power to erect there from the landlord. In the summer we gave a regular flow of water when it was wanted. I can only remember the supply being exhausted once in 25 years.

MONDAY, MAY 1.

Professor *Douglas Maclaren*, examined by Mr. CLERK.

I am a doctor of medicine in Edinburgh, and professor of medical jurisprudence in the Edinburgh University. I have to give instruction on what is called medical police, including the question of supply of water to towns. I have frequently been employed by the Crown to make investigations for them on matters relating to medical jurisprudence. Like all citizens of Edinburgh, my attention has been a great deal drawn to the question of the supply of water to that city. The present water is generally good in quality, but deficient in quantity. It is, however, liable to become turbid, especially after rain or stormy weather. When it is settled down and clear, it is good in quality, but deficient in quantity. It is often loaded with particles of clay after the circumstances I have mentioned, and that would particularly affect the poorer classes, who have very few cisterns in Edinburgh. A good deal of building and fencing of land is going on round Edinburgh. I have made a general examination of the St. Mary's Loch water. I observed the streams and feeders flowing into the loch; they are of such volume as to prevent any probability of stagnation. Indeed, I cannot understand how St. Mary's Loch could have any stagnation, considering that the Little Yarrow goes in at the top of the loch, the Yarrow flows out at the bottom, the Meggett flows in at one side, and another burn flows in at the other. In a medical point of view, it is an important consideration in securing a constant flow of fresh water into a great natural reservoir. I have seen the reports of analyses made by Dr. Stevenson Macadam. The water of St. Mary's Loch is good, and well adapted for the consumption of a large town. It is well adapted for cooking, drinking, washing, and for general domestic purposes. My attention was drawn to the letters of "A Physician" in an Edinburgh paper, and I am aware of the objections made in those letters with regard to the quality of the water. I am not aware of any facts known to science which substantiate the proposition that the fact of water being of a soft character interferes with the nutrition of the human body, bones or otherwise. I examined the waters of the Talla and the Heriot in a general way. They contain about the same quantity of lime as St. Mary's Loch. These waters are very much of the same character, and they contain quite sufficient lime to assist the growth of the human body. I generally concur with Dr. Wood's evidence. I have searched for the water fleas at St. Mary's Loch, but have not found them. I kept a sample of St. Mary's Loch water, which was taken on the 17th of February. It was unfiltered, and was taken out of the proposed outlet to the lake. This sample remained in my warm study until the 25th of April. At that date no insects had developed themselves in the water, although I made a microscopical examination. The water was still good in taste, and thoroughly wholesome. I do not think it likely that this water will be injurious to leaden pipes. From my general knowledge of the water in St. Mary's Loch, and from Dr. Stevenson Macadam's analysis of it, my opinion is that that water is well adapted to supply the deficiencies of Edinburgh.

Cross-examined by Mr. RODWELL: This question of lime in water has been very much discussed among French scientific men, and some of them share the opinion of the "Physician." I am aware that a French commission considered the question of supplying the troops with water, and that they went 70 miles from Paris in order that they might obtain hard water instead of soft. I think the engineers took them away so far in order to get it distributed by gravitation and not by pumping. Professor Christison is an authority on this subject. He stated in his book on poisons that spring water containing less than 4·66 grains of saline matter per gallon would be injurious if conveyed through leaden pipes. I do not endorse that statement, because, since the book was written, there has been a complete revolution in the medical profession on the subject of the effect of water upon lead. That revolution took place at the time of the establishment of the Glasgow Water-Works. My own idea is that the Glasgow water does not produce any bad effect. I think it is safe to use as soft a water as you can get, and to store it as you do, but it must not remain stored long. Rain water and melted snow are the softest kinds of water. I would not venture to pass those kinds through leaden pipes, because they are ill aërated waters. It is inexpedient to use snow and rain water, because of the absence of saline matter, which is only about 2 grains, or a little more.

Mr. RODWELL: Would not that poison a town?

Witness: It depends on how long it is kept.

Mr. RODWELL: If it were kept 48 hours, would it not poison the people who drank it?

Witness: I have great doubts on that point. Very likely deaths have occurred at Amsterdam, occasioned by soft water passing through leaden pipes; but they are supplied there with abominable water. A great number of decomposed fleas in the water would render it unwholesome.

By Mr. MUNDELL: When I visited St. Mary's Loch on the 15th of April, there had been about three days rain, but the feeders were not full. I saw only one burn that was at all turbid.

Re-examined by Mr. CLERK: The water in Paris contains a great deal of gypsum and sulphate of lime. There are two waters in Paris—one a bad water, which is not used for anything but cleaning the streets; the other water contains so much sulphate of lime that it excites diarrhœa. The last edition of Professor Christison's work was published at least 30 years ago. When the Glasgow Bill was applied for, a great deal of alarm prevailed in consequence of the effect it was supposed so pure a water as that of Loch Katrine would have upon lead. The bill was in the first instance rejected on this account. I know of no injurious consequences having resulted from bringing into Glasgow a softer water than that of St. Mary's Loch. I saw no fleas, living or dead, in the water I received from St. Mary's Loch. I have seen samples of water containing fleas from the Pentland Hills. If there had been any organic remains of the fleas, I should have found ammonia. No trace of this appears in Dr. Macadam's analysis.

Mr. *Adam Thompson*, examined by Mr. CALVERT.

I am a commissioner of police and town councillor of Galashiels, where I have resided 30 years. Galashiels is a place where the manufacture of tweeds is carried on to a great extent. The river Gala, which comes from Kemplaw, runs through the town for about a mile and a quarter. For about eight months of the year the river is in a very bad condition, standing in stagnant pools and giving off a very disagreeable effluvium. It requires to be scoured by floods in order to keep it in a tolerable state. If the water were diverted, so that these floods could not come, Galashiels would suffer very much. Galashiels at present has a very inadequate supply of water. The Heriot is one of the tributaries of the Gala. The population of Galashiels has risen from 6437, in 1861, to 9678 in 1871.

Cross-examined by Mr. WILL: I was first asked to give evidence on this question last week. Many of the Galashiels manufacturers are obliged to work by steam in consequence of the defective supply of water.

By Mr. MACDONALD; The Galashiels manufactures are increasing. The St. Mary's Loch supply would suit us well if the Heriot water were taken away.

By Mr. MUNDELL: If we had a compensation reservoir and a full summer supply to the Gala, we should still object to the Heriot water being taken. We require the summer floods to clean the bed of the Gala.

Re-examined by Mr. CALVERT: We want the floods, and no compensation can be adequate to that want. Galashiels could not obtain St. Mary's Loch water for itself; there are too many difficulties in the way. It could only get it through the water being supplied to Edinburgh.

Mr. *Robert Paterson*, examined by Mr. CLERK.

I am assessor for the city of Edinburgh, under the Valuation of Lands Act (Scotland), and I am also assessor under the Registration of Voters Act (Scotland). It is my duty to prepare annually a register of voters, containing the

names and designations of all persons entitled to vote in parliamentary and municipal elections. I have made an examination of the petition against this bill, and I am prepared to show that many of the signatures to it are fictitious. It pretends to be a petition from the ratepayers of Edinburgh. In very many instances the names are written in the same handwriting, and are not the signatures of the people really possessing those names. In another case the name and address and rental of the persons in one part of the petition are also found in another part, the name of the supposed person being written manifestly in different handwriting. As evidence of the state of feeling in Edinburgh, the petition is entirely worthless. The rentals, in many instances, are grossly exaggerated.

The CHAIRMAN stated that the committee were of opinion from the general appearance of the petition that it was genuine, but they would not express any opinion whatever as to how far it might be otherwise.

By Mr. CLERK: The increase during the last 16 years of the annual value of the property in Edinburgh is £452,128, or about 60 per cent. The rental of the city now is £1,214,246 in Edinburgh alone; the rental of Leith is £234,094; and the rental of Portobello is £32,645—making a total of £1,480,783 for the three burghs. The increase in Edinburgh alone last year was £55,300. The present rental of the three burghs is in excess of what the rental of Glasgow was when the water-works where introduced there. In 1855, when the water-works were introduced into Glasgow, the rental of that city was £1,362,168. It has, however, very largely increased, and is now £2,126,324.

Mr. *W. H. Cameron*, examined by Mr. CALVERT.

I am treasurer and collector to the Edinburgh and District Water Trust. For upwards of 30 years, I was clerk to the Edinburgh Water Company. With the assistance of the engineer, I have the distribution of the water under my management. I am satisfied that a large additional supply is needed. There has never been a full supply of water to Edinburgh, Leith, and Portobello. Complaints have been numerous in the time of the company and up to the present time. A thorough inspection of the whole apparatus of supply has been made since the works came into the hands of the Trust. Upwards of 30,000 houses have been visited, and every part of the apparatus examined in each house. To a great extent the apparatus has been repaired, but the Trust, with all their improvements, cannot supply sufficient water to Edinburgh. The late water company were never able to give a constant service.

The CHAIRMAN: On the second day of the committee, it was agreed that it is unnecessary to give any more evidence as to the necessity of a large amount of water for Edinburgh.

Examination continued: The income of the Water Trust during the current year, ending at Whitsunday, is £31,670 from the domestic rate, and 12,807 from the trade rate, but after deducting irrecoverable arrears, &c., the gross income is £44,205, the expenditure is £42,165, leaving a surplus of £2100. The revenue for 1872-3 is calculated at £46,115; the domestic rate is calculated at 8d. per pound, and 3d. for shops. In 1873-4 there is no alteration. In 1874-5 we propose increasing the water-rate to 10d., and to make a charge for water supplied on small houses at £4 rental instead of £5. In 1875-6 the rate is proposed to be increased to 1s., and we add a little more to our trade charges, because we expect to have the St. Mary's Loch water by that time, and there will be more water to sell. In 1876-7 the rates will be the same as in the preceding year. The expenditure for 1871-2 is calculated at £41,790; 1872-3, at £45,140; 1873-4, at £51,790; 1874-5, at £60,440; 1875-6, at £62,990; 1876-7, at £65,240. That will give a surplus in certain years, and a deficiency in others. The surplus in 1871-2 will be £3800, which, with the surplus in the current year, will make a total of £5900. In 1872-3 the surplus will be only £975, which (with the previous balance) will make £6875. In 1873-4 there will be a deficiency of £5135, the rate being still kept at 8d. per pound, and deducting this amount the real surplus will be £1740. In the following year there is also a deficiency, but in 1875-6 the rate will be raised to 1s., and there will be a surplus of £8440, and deducting the previous deficiency, there will be left at Whitsunday, 1876, a surplus of £4810. In 1876-7, there will be a surplus of £9155, making altogether at Whitsunday, 1877, a surplus of £13,965. At that time we expect the accounts will be clear enough. I made all the calculations for the old water company, and kept their books. There is a charge for interest upon the whole amount proposed to be borrowed under the bill, and we suppose that in 1877 the whole of the money will have been expended. We have calculated, however, what amount will be required each year. The miscellaneous expenses are charged in accordance with the results of my own experience.

The CHAIRMAN: Is it contemplated, if this bill is passed, to close the existing water-works?

Witness: No.

The CHAIRMAN: Then there is a charge for maintaining the present works in addition to those works proposed to be made under the bill?

Witness: That is all included.

By Mr. CALVERT: We have allowed, in this calculation, the rents to be paid annually to the old company's shareholders, and also for the expense of the new undertaking.

Cross-examined by Mr. WILL: The amount put down for repairs in 1871-2, is £1000. The old works are costing us at present £2500. I will explain that. Some of the reservoirs were very much out of repair. The Water Trustees ordered all the reservoirs to be put in thorough repair. We have already spent a considerable sum in this way, but we calculate that the average cost of keeping up the reservoirs will not exceed £700, although I have calculated £300 more. I estimate wages at £1625.

Mr. WILL: In point of fact, you have only got £75 additional for the St. Mary's Loch scheme and all the attendant works?

Witness: But there are no works required. There will be one cistern at the loch itself, and one at the town.

Mr. WILL: Then £75 is all you think necessary for that?

Mr. CALVERT: It is £1700 now; it will be £2000 when the works are all in operation.

Mr. WILL: But the rise in your estimate for the next four years is £75?

Witness: We do not require any extra men.

Mr. WILL: That is what you say. We will hear what the engineers have got to say on that point. The law expenses and outlay connected with loans you put only at £1000 next year.

Witness: That is because there will not be much money borrowed then.

Mr. WILL: Will there be less borrowed next year than this year?

Witness: Yes; we cannot borrow money to pay works till they are entered upon.

Mr. WILL: In the fifth year you allow £700, while for the next year it is only £250.

Witness: Because the money will be all borrowed by that time. We will raise it gradually. The printing, stationery, and advertising, and miscellaneous expenses we calculate at £750. The item has been large this year, in consequence of the transfer of the works. The transfer stamp alone cost between £600 and £700. We have also had to buy books and stationery. The water company allowed £500 to their directors. There is no such fee allowed to the Water Trust. Our first amount borrowed is £170,000, which includes the debt of the old water company. Before Whitsunday next we propose to borrow £50,000, making the total debt at that date £220,000. We calculate that in 1875-6 the works will be made, and that we shall be deriving a revenue from them. The public water-rate is not usually reckoned merely a security. It is always raised, and has been so in Glasgow, Greenock, and Dundee. I do not concur with Mr. Gale that we might do in Edinburgh with less than 32 gallons per head per day, even with good fittings.

By Mr. MUNDELL: Supposing no new works are made, we have a use for the £50,000 we propose to borrow. We will require to raise that irrespective of the new works.

Re-examined by Mr. CALVERT: In consequence of our outlay we shall have less to anticipate hereafter in repairs. The public water-rate is to be raised the year that the water-works come into operation.

By the COMMITTEE: Last year there was an accumulated surplus of £13,965. If the water-works were to be very prosperous, we should not be compelled to charge the shilling rate. All we should be bound to provide for would be the redemption of the debt, and, if we could do it at 11d. or 10d., we might. We borrow all our money at 4 per cent., and we propose that the rate should be an unlimited rate, in order to enable us to borrow money better, and we have allowed 1 per cent. in the law expenses for renewals.

By Mr. WILL: No water ran to waste last year. Our books record that.

Mr. *Robert Adam*, examined by Mr. CALVERT.

I am the accountant for the corporation of Edinburgh. I corroborate the accounts and the bases of their calculation given by the previous witness.

Mr. *J. W. Stewart*, examined by Mr. DENISON.

I am engineer to the Water Trustees. I was desired by the Corporation of Edinburgh, Leith, and Portobello to make a report in reference to the water supply. I made a report, and recommended a new supply from St. Mary's Loch, which fell through in 1868. I estimate the present supply as equivalent to 28 gallons per head. We have 5 million gallons from springs, and 2 million from impounded water. That quantity is quite inadequate. I recommended St. Mary's Loch for the following reasons:—First, the existence of a large natural reservoir, which superseded the construction of embankments; secondly, the character of the surrounding district, there being steep hills and no cultivation. Then there is a large rainfall, abundant springs, and the water of the lake was pure, there being no decaying matter in it. There is also a large volume of the chief supply coming in near the middle of the lake, and therefore in wet weather, when it does come, it does not pass out of the lake for months afterwards. The water may be taken as the purest possible. The sources nearer Edinburgh are subject to certain disadvantages. The first is the construction of large reservoirs, which are always attended with great expense and risk. The purity of water stored in a reservoir necessarily deteriorates in the course of time. In the next place, I object to the smallness of the rainfall near Edinburgh; and, lastly, to the quantity of the supply, contrasted with the almost inexhaustible supply at St. Mary's Loch. We should at once exhaust the water districts nearer Edinburgh. Whenever we wanted a fresh supply, we should have to go into a fresh district; whereas, by the proposed scheme, we should merely have to enlarge the works. I made a report in September last. In that report I did not recommend any scheme to be adopted, but simply stated what the circumstances were that were in favour of each scheme. The trustees visited the districts, considered the whole scheme, and recommended St. Mary's Loch. I was then directed to prepare a plan of the scheme and works. [Report handed in.] The exact length of the loch is about four miles. It is 8000 feet above the level of the sea, and the ridges rise from 1000 to 2000 feet above the level of the sea. I propose to tunnel through those ridges.

By the COMMITTEE: The pipe across the vale of the Tweed is 3 feet in diameter; the tunnels are 7 feet.

By Mr. DENISON: The aqueducts and tunnel are large enough to carry ultimately 24 million gallons. The first syphon-pipe is 3 feet in diameter, and the other 2½ feet. The Straiton reservoir will be opened, and will hold one and a half day's supply; if necessary, it will be covered over with a light roof. My estimate is £457,000 for works, land, and contingencies. The supply of 12 millions is in addition to 7 million gallons given now—19 millions in all. As compensation to the millowners, we give them the supply from the area of the two lochs at 28,000 acres, and the rainfall over it is equal to 46 inches, ascertained by the gauges of the trustees. Our parliamentary estimate is £480,000. Allowing for these compensations out of the 46 inches, I reckon 7 per cent. for the corporation during nine months, but about one-third of the rainfall will be again returned in the shape of springs. We get an available rainfall of 13 inches. I think 1670 feet, or 15 million gallons per day, fair compensation to the stream for the abstraction of the whole 24 million gallons. That is not more than the usual proportion given to streams when water is taken, but the millowners on the Yarrow will be better off. They will, at least, have half as much again; probably three times as much. The mills at Selkirk are 16 miles off. We propose to take powers to run off the loch 18 feet deep, which is equal to 500 million cubic feet. We shall have altogether storeage for 800 million cubic feet, which will give a supply for 120 days.

Cross-examined by Mr. RODWELL: St. Mary's Loch was the first place I visited in my search for a water supply. I wish to secure one and a half times the present supply. I thought 50 gallons per head requisite. We can get nearly 100 gallons per head from St. Mary's Loch.

Mr. RODWELL: That would give you, in addition to the present supply, about 125 gallons for Edinburgh, or 75 gallons more than you say they want.

Witness: That is not the proper way of putting it. In our present water-works we have 28 gallons per day. If we get St. Mary's Loch we shall have 95 additional, or 123 gallons.

Mr. RODWELL: That is nearly 75 gallons more than you want.

Witness: It is more than we want now; but if the population goes on increasing as it has done, we shall require 70 gallons, and in another ten years we should have to go in for the extra 12 million gallons which we took power to supply, but that would be in 1891.

Mr. RODWELL: Do you consider it fair on the ratepayers of Edinburgh that they should be called on to pay for an enormous excess of water beyond their wants for the next 20 years?

Witness: I think so. They have already had to pay very dearly for their water supply. I think it would be perfectly absurd to go for less than we now ask for. Nine million gallons per day would last until 1886. I believe I made my estimate upon the supply going to Glasgow. Because Glasgow had 50 gallons per head, I thought Edinburgh could not do with less. There is great waste in Edinburgh. It cannot be avoided by a better system of plumbing. It arises through the carelessness of the people. I have heard the water has been economized in other places, but I do not believe it. I consider that the waste is useful in a sanitary point of view. The aggregate of all the little tricklings from the taps becomes a considerable stream, and finds its way into the sewers and drains, and helps to keep them clean. My attention was drawn to South Esk. Not more than 4½ millions of good water could be got from that source. I cannot say whether the expense of that scheme would be one-half of the St. Mary's Loch scheme. My estimate is £575,000 for the Esk and Heriot combined, which is dearer than St. Mary's Loch. The South Esk scheme I estimate at £193,000.

The CHAIRMAN: Would not the taking away of the portion of the South Esk, which we have already given to Dalkeith and Musselburgh, prevent you from giving 9 million gallons to Edinburgh?

Witness: Most decidedly.

By Mr. RODWELL: I differ considerably from Mr. Leslie's conclusions.

The CHAIRMAN intimated that the committee having already decided on devoting the water of South Esk to a certain purpose, could not now appropriate that water to another purpose.

Mr. RODWELL said that he proposed to show that, considering the limit in the amount to be taken under the Musselburgh Bill, there would still remain 9 million gallons for Edinburgh.

The CHAIRMAN stated that the amount to be taken for Musselburgh and Dalkeith was limited, because certain compensations were required.

TUESDAY, MAY 2.

Mr. *J. W. Stewart* recalled, and cross-examined by Mr. RODWELL.

I differ considerably from Mr. Leslie as to the desirability of the South Esk scheme. Mr. Leslie was of the opinion that the Heriot scheme would afford 9 million gallons of water a day for the use of the town. He said it was a very good and feasible scheme, and would afford an ample supply to Edinburgh for many years to come, and it might have a considerable quantity of the water of Middleton Burn added to it in its course to Edinburgh. The cost, Mr. Leslie estimates, would be £259,000. I agree with Mr. Leslie that 9 million gallons might be brought from that district. That is not so much as would be required to supply Edinburgh for the next 15 years. I think that supply would be exhausted by the year 1886. The addition of 36 gallons per head per day would be sufficient only up to 1886, when the supply of 50 gallons would have to be supplemented. The water would gradually diminish as the population increased.

Mr. RODWELL: And for the next 15 years you would have more water than you actually required?

Witness: Yes; but before the year 1886 arrived the trustees would have to look out for fresh sources of supply.

Mr. RODWELL: Would you not also have a considerable portion of the Middleton Burn added in its course to Edinburgh?

Witness: The water is quite unfit for domestic use. It is nearly entirely peaty.

Mr. RODWELL: Then I have your concurrence in this view of Mr. Leslie's—that up to the year 1886 there would be secured a supply of 50 gallons a head per day if the sum of £259,350 was paid now?

Witness: Mr. Leslie estimates the cost of the whole scheme at £259,350, whereas the cost of my reservoirs alone comes to £280,000, exclusive of the cost of conveying the water to Edinburgh.

Mr. RODWELL: I suppose you have made estimates for water-works independently of this scheme?

Witness: Only in connexion with Edinburgh, Dundee, and Dunfermline. You cannot make a true estimate of the cost of a reservoir unless you know what the nature of the soil is. The district I have been speaking of is the lower silurian, but all the districts are not of the same character. The sites of my proposed embankments are very similar to those on the Pentland Hills, and therefore I have calculated that the reservoirs would cost about the same sum as those on the Pentland Hills. I made no borings. There is a considerable quantity of gravel in the vicinity of St. Mary's Loch, at the mouth of the loch. I have taken that fact into consideration. It does not increase the expense. If we could have a solid rock bottom, however, it might suit our purpose better. In my estimate, I have made no allowance for filtration. That would cost from £18,000 to £20,000 in addition. I have allowed 20 per cent. for contingencies when there is anything in connexion with water, 10 per cent. for tunnels, and 5 per cent. for pipes. The reservoir No. 5 was to be an open one, unless it were found that the smoke injured the water. The cost of roofing that reservoir would be £30,000 or £40,000. I should propose to roof it with tiles. The embankment at St. Mary's Loch scarcely deserves that name, as in fact it is only a weir. The soil there is gravel. I should have no difficulty whatever in putting a weir upon this gravel soil. I heard Mr. Leslie's report read before the trustees. In addition to disagreeing with him about the estimate, I likewise disagree with him in regard to various other details. Mr. Leslie and I compared our estimates together, and I gave way for the sake of peace. That must have been in October last year. I believe there are 511 million cubic feet in St. Mary's Loch fit for storeage. I got at that quantity by calculation. I have considered the capabilities of the Pentland Hills, but I abandoned them, because I thought they were not capable of yielding the supply we want. I could get from the Pentland Hills an additional supply of 4 gallons a head.

Mr. RODWELL: What is the escape over the weir?

Witness: In 1868 (a very wet year) it was 219 million cubic feet; in 1869 it was 157 million cubic feet; last year nothing escaped. The reservoirs never filled up, and we were short by something like 44 million gallons. My estimates do not include the town piping. That would be £50,000 in addition. None of these estimates include the town piping. My estimate includes land. [Mr. Leslie's report handed in.]

Mr. RODWELL: What is the difference in average between the high and the low level?

Witness: 723 acres is the extent of the surface of the water—that includes both lakes—and when the water is drawn down there are 624 acres, which makes a difference of 89 acres. The St. Mary's Loch has a surface of 626 acres, but when the water is drawn down 18 feet, it is only 516 acres. The Loch of the Lowes has 76 acres when drawn down, and 99 acres at the surface; that makes a difference of 23 acres in the Loch of the Lowes, and 110 acres in St. Mary's Loch, or 133 altogether.

By Mr. MUNDELL: The weir I have spoken of would be 7 feet above the bed of the river. The ordinary winter level would be left nearly as it is at present. We propose to construct a weir 580 feet wide, in order to keep down any winter floods. If we reduce the lake by means of our pipes 18 feet, we should make it 13 or 14 feet below the bottom of the sluice. I agree with Mr. Leslie that it is a fitting place for a water supply to be taken from. The compensation is taken from the same source, under a local Act, I think. I agree with Mr. Leslie that that is a proper mode of taking it, although I almost forget what Mr. Leslie said on the subject. The level of the Loch of the Lowes is 3 feet 4 inches lower than that of St. Mary's Loch. In the summer time, the result of reducing this 3 feet 4 inches would be to lay bare 23 acres out of 99. I took soundings in front of Rodondo House, at the north end of the bay. At a distance of 200 feet from the edge, the winter level of the water is 20 feet in depth. I am not surprised to hear that the loch is now 17 feet deep at a distance of 140 feet from the shore. The shore is very circular there. According to my soundings, it is 200 feet from the winter level to gain 18 feet in depth. The winter level is 4 feet higher than the summer level. Mr. Leslie did not agree with me as to the sufficiency of storeage, according to the parliamentary plan. I hold that the storeage in that plan is sufficient. The bill provides for the storeage of 1670 million cubic feet per month for 120 days, which equals 288 million cubic feet. The storeage, in this case, is 511 million, leaving a balance for the town of 223 million, to which is to be added the summer flow of the stream. I have never gauged the summer flow of the streams that come into the loch, nor the Little Yarrow. The other burns and brooks are too numerous to be gauged accurately. I am of opinion that the storeage will be sufficient to give all that is required according to your scheme. The total quantity of water which could be collected in this reservoir would be 3893 millions of cubic feet; that would be 66 million gallons per day. This would be drawn off every day, if the whole of the water were impounded. If all that quantity were drawn out, the storeage would have to be increased so as to impound the whole of the water in the district. The loch falls very low in some seasons, and the millers have the right to impound the water to a certain extent.

By Mr. MACDONALD: We have had only one year of rainfall for the gauging of St. Mary's Loch. That was the year 1870. That could hardly be called a dry year, for we had a considerable flood in May. The rainfall was very equally distributed last year. I do not think it was a dry year for that district. The gauges kept at four places in the district gave us ample information concerning the rainfall. We had only one year of actual gauging, but we can fall back on the gauges of the Meteorological Society all over the kingdom.

Mr. MACDONALD: Have you the tables of the Meteorological Society from which you have been making your comparisons?

Witness: Yes: I will give you the names of the gauges: Corsecleuch, 1500 feet above the level of the sea; Megget Head, 1750 feet; Craigie Rig, 920 feet; and Dryhope, 820 feet. The rainfall in the district last year was, on the average, 46 inches. I get that result by lumping together four gauges, and dividing them by four. I think that is a fair test of the whole district. I have never tested the Yarrow, at its junction with the Heriot, nor the Ettrick, at its junction with the Yarrow. I never gauged the Ettrick at any point. In estimating the compensation, besides my calculation of the rainfall, I took into consideration the minimum flow of the stream. I think the proper compensation to millowners is the average flow of the stream throughout the summer months, and that I take to be the minimum flow, *plus* the half. The average flow from the Loch Katrine district in 1870 was, I think, 1 cubic foot per second, or 60 cubic feet per 1000 acres, which is just the average flow which has been adopted here.

Mr. MACDONALD: Have you obtained the average flow from anything other than the rainfall?

Witness: It was impossible to do any other so long as the millowners commanded the sluices. I have had measurements taken of other streams than those for which this supply is to be taken. That is the only way in which we could get at the facts. I do not know the proportion the St. Mary's Loch bears to the whole of the water which runs past Selkirk. If ascertained, it would be a very important element in the compensation. The soil of the St. Mary's Loch district is not very retentive of water, but I think it is a very good spring-producing district. It is not quite so good as the Pentland district; but still I think it will produce a good deal of spring water, and, therefore, I have put it at a very high minimum. I have no doubt that the minimum will sometimes go down to half of what I have put it at. My minimum is high in comparison with Loch Katrine and places north of Aberdeen.

Mr. MACDONALD: Do the millowners at Selkirk get more water than they would if the loch and its outlet were in their natural state?

Witness: They get more water below the lake. They get water from the Ettrick.

Mr. MACDONALD: From St. Mary's Loch they get more water for the use of their mills than the minimum flow out of the loch itself?

Witness: Yes; they have had up to this time the command of the sluice, which gives them some more.

Mr. MACDONALD: And will they be deprived of that command if this bill passes?

Witness: They have been deprived of it already, before they came here.

Mr. MACDONALD: And do you propose to give compensation to the millowners for the loss of the sluice?

Witness: If they have no right to the sluice they cannot claim or be entitled to receive compensation. I have not made any allowance for compensating them. The outlet to the loch is pretty wide, and the water will soon run off; but no doubt it does impound the water, and the millowners get the benefit of it. The width of the outlet, when there were about 10 inches of water running out, was 55 feet. I think there is plenty of water in the loch without any additional storeage being provided. The compensation to streams varies on the rainfall. I did not allow 50 per cent. for compensation in the Talla and Heriot schemes, allowing for the impounding of water. In those cases I intended to provide a reservoir capable of holding one-third of the quantity taken to the town continuously throughout the year. I originally proposed there should be artificial storeage upon the Meggat and the Douglas Burn. They are both below the mouth of the loch. I have changed my mind as to the Meggat. It was then only proposed to take 18 million gallons to the town, and to draw the loch off to the extent of only 10 feet. Mr. Leslie, in his report, makes no allowance for a stream which flows into the loch. I differ from him as to the advisability of taking a stream which flows into the loch into consideration when deciding upon the question of storeage. It will be necessary to go 21 feet down the loch to secure our storeage. A compensation reservoir could be made on the Meggat at a very small cost.

Mr. MACDONALD: Why do you give up providing that compensation?

Witness: Mr. Bateman recommended that we should rather draw the loch off to a lower depth, and we drew 8 feet more off. At that time it was only possible to draw off 10 feet, and we now draw off 18. The compensation outlet will consist of four or five sluices placed at different levels to allow the water to flow into an open aqueduct which is to convey it both to Edinburgh and Selkirk. The water will be got from the aqueduct to Selkirk by a side weir, and without pipes. There will be a "notch" in the side of the aqueduct, into which the water will flow into the channel leading down to the Yarrow. I produce copies of the rainfall gauges which have been taken. The width of the proposed aqueduct from the point at which it leaves the loch to where the compensation water will be given off will be 10 feet, after which it will grow narrower. It will be a simple open channel, to a slope of 1 to 1 at the bottom, and 1½ to 1 above.

Re-examined by Mr. CLERK: I have carefully reconsidered the whole question, and gone into it with Mr. Bateman, the result being a modification of my first report. Comparing the rainfall in different parts of Scotland in the dry season of last year, I found that in the Yarrow district it was considerably in excess of that in the Pentland and Mid-Lothian districts. The quantity of water available for town supply can only be ascertained by an examination of the rainfall, unless a weir be built for the flow of the water, carefully tabulated for years—a process which would be not only lengthy, but very expensive. The compensation water proposed to be provided gives the Selkirk millowners a much better supply than they have at present, because they would have a supply in dry weather. I do not think that Mr. Leslie, in his calculation of the cost of the Heriot scheme, includes the cost of buying the Borthwick Hall property of the late Lord Provost. It would not be necessary to buy the whole of the property. The adoption of the scheme would entail strong opposition on the part of the millowners of Galashiels. If we were limited to a supply of 9 million gallons, we could get it more cheaply from St. Mary's Loch than from the Heriot. The embankments and other works necessary to carry out the Heriot scheme, according to Mr. Leslie's plan, would, in my opinion, prove enormously costly. Mr. Leslie treats this district as he would a district in which the streams always dry up in summer. If a large artificial embankment were raised in St. Mary's Loch, according to Mr. Leslie, it would involve sinking down very deeply through the gravel in order to reach the solid rock, and would be a very costly work. Mr. Leslie treated many of these questions as resulting in little more than a guess as to the question of cost. In examining the Talla, the Lyne, and the Heriot, they were discharging as the minimum 170, 155, and 200 cubic feet per minute. We have room enough to spend from £18,000 to £20,000 in the making of a filtering reservoir, and to cover it over, if necessary, at a further expense of from £3000 to £4000. I was authorized by the trustees to make such a provision, if necessary, but I do not think it is necessary. If we drew off 18 feet from St. Mary's Loch it would uncover it 110 acres. We shall probably never reduce it below 7 feet, and that includes not only the town supply, but efficient compensation. That would make a difference of perhaps 60 or 70 acres. About 39 acres are at present uncovered. I estimate the cost of the tunnels at £12 the running yard.

Dr. *E. Frankland*, examined by Mr. POPE.

I am president of the Chemical Society, and one of Her Majesty's commissioners to inquire into the pollution of rivers. I visited, on the 26th of September, 1870, the Heriot and St. Mary's Loch districts, to ascertain their suitability as regards the gathering-ground. I took samples and analyzed them. The St. Mary's Loch water is good and wholesome, and fit for all domestic purposes except brewing, for which purpose it is too soft. What is commonly called the

water flea was present in the Loch at the time of my visit, but samples which I have recently received from Dr. Macadam contained none. I have repeatedly seen them in water of undoubtedly good quality. The Manchester water, for instance, very frequently contains them, even as delivered in the town; and Manchester water is justly considered one of the best waters in the kingdom. There is no harm whatever in the creatures that I know of. There would be no difficulty in getting rid of them by filtration. The St. Mary's Loch is one of the best waters in Scotland. This water, notwithstanding softness, could be safely transmitted through pipes and stored in lead cisterns. Although it slightly acts upon bright lead, yet it would not affect the water in a cistern. Roughly speaking, the Loch Katrine acts a hundred times more upon lead than the St. Mary's Loch water. It is found to cause no inconvenience in Glasgow.

By the COMMITTEE: The water fleas are about one-sixth the size of domestic fleas. They swim about under the surface. Any single cubic inch might contain a flea, but it would be rather surprising, if you took several separate cubic inches, to get a flea in each. Taking a sample of water from Loch Katrine, I used a vessel of bright polished tin containing an imperial quart. I did not count them; but so far as my recollection serves me, I should say that there would be from three to six of them in this. In St. Mary's Loch water I should say that they constitute one of the most important parts of the food of fish. They are consumed to a great extent in streams containing fish.

Cross-examined by Mr. RODWELL: I strained these fleas off before I analyzed the water, because the process of analysis is so delicate now that I believe the presence of a few of these fleas would produce a very perceptive difference in the result as regards organic matter. The object of the analysis was to ascertain the quantity of organic matter in solution. I have not heard of these animals causing disease, I cannot say whether they are carnivorous. I think there is a strong and proper prejudice against people being supplied with water containing these fleas.

Re-examined by Mr. POPE: Fleas are generally present in impounded waters. When I said it is a wholesome prejudice I had in my mind that there is so much water drunk that is contaminated with excremental matters that the presence of these things shows that the water has not been properly filtered, and to drink water that was contaminated without being sufficiently filtered is dangerous. I should expect to find animalculæ in an artificial reservoir at certain seasons of the year in the same degree in which I found it in a natural lake. They constitute the principal food for fish.

By the COMMITTEE: Fleas are present in the London water prior to filtration, but not afterwards. When I refer to filtration I mean that which is performed by the water company through a stratum of sand, and not domestic charcoal filtration. A very fine copper gauze strainer would strain off the actual living flea, but would allow the ova to pass through, and these would be afterwards developed in the main or in the cistern of the consumer.

J. F. Bateman, Esq., examined by Mr. POPE.

I am a civil engineer. I am engineer for the Manchester and Glasgow Water-Works, and have a very large experience. In October, 1868, I was consulted with reference to an additional water supply for Edinburgh. Mr. Stewart came to see me in London, under the instructions of the corporation, for the purpose of advising as to the plans which he had proposed for a supply of water from St. Mary's Loch. The scheme was so simple in itself, and so similar to the Loch Katrine scheme, that I had no difficulty in declaring it to be a perfectly feasible plan, and one the cost of which could be estimated within reasonable limits, and that, together with an estimate, was about the sum of my report at that time. In the first week in November I went over the country with Mr. Stewart, for the purpose of settling various details of the project. In January, 1869, in consequence of a question arising amongst the ratepayers and other inhabitants of Edinburgh as to whether there was not a cheaper and better scheme, I received instructions to report upon what was really the best scheme for Edinburgh, and with that purpose I studied the whole of the country, visited the district, and had a certain amount of preliminary surveys made by a competent assistant. I wrote a report. I was not fettered in the slightest degree, nor had I any prejudice in favour of any particular scheme. I went into the matter in the same way as I did when engaged under precisely similar instructions by the Corporation of Glasgow many years before. I examined all the districts from which any supply of water could be obtained at a reasonable cost, but those only which, in my opinion, were worth consideration on the part of the corporation were the South Esk, the Heriot, and the St. Mary's Loch. The South Esk district was capable, according to my view, of supplying about 8,400,000 gallons a day of water, after compensation being given to owners, for an outlay, as I then estimated it, of £243,000, exclusive of filtration. That was what I estimated the South Esk would yield; but, of course, the Musselburgh people having once planted themselves in that district, it is lost to Edinburgh. The water remaining after the Musselburgh people had their supply would not be fit for the use of Edinburgh. The Heriot is the next district beyond, and that would have yielded 9 million gallons a day for a cost of £306,000. Together, I estimated that the two districts would have yielded 17 million gallons a day at a cost of £550,000. My estimate for the Heriot scheme was exclusive of compensation to be given to a landowner in that district. The Heriot and South Esk districts are being rapidly brought into cultivation, which constitutes a serious objection to their being resorted to. I estimated that the St. Mary's Loch would yield 24 million gallons a day, as far as the storeage, tunnels, conduits, &c., went. The pipes were laid down on a scale of 12 million gallons a day immediately, and 24 millions ultimately, and I estimated the cost at £400,000. In St. Mary's Loch no artificial embankments are needed. You have a reservoir ready to hand. The slopes are beautifully beached by gravel, so that no discoloration can take place by the action of the water. As to animalculæ, there is no impounded water which does not, I believe, contain them at certain seasons. I was absent in South America last winter, and Mr. Hill, my assistant, inspected the ground, and made an estimate. There is no more competent man in the kingdom than he. On my return I went to Edinburgh, and, at an interview with the trustees, I was appointed principal engineer, and requested to go over the ground, inspect it, and asked to support the bill in Parliament. I visited the district on the 13th of March. I consider Mr. Stewart's estimate for the execution of the works sufficient. My estimate is totally independent of Mr. Stewart's. The area of St. Mary's Loch is 723 acres, and the basin 27,520. The water surface is 1-38th of the whole collecting-ground. My estimate is divided into four parts. There is the outlet-works at St. Mary's Loch, the cut and covered conduit (being a built conduit for conveying the full quantity intended to be taken), the two tunnels through two intervening bridges, and the iron pipes across two valleys. The outlet at St. Mary's Loch will cost £17,500, which I have calculated at 50 per cent. more than the expense of constructing the Loch Katrine works, taking the two proportionately. The tunnels I have also estimated higher in proportion than those at Loch Venacher and elsewhere. The first tunnel, which is a comparatively shallow one of 6268 yards in length, I estimate at £10 2s. 10d. per yard. I produce photographs of the outlet-works. Above the outlet there is a value-house. There are four ladders to assist the salmon to the height of the water in the loch, so that the salmon can get up and down. My estimate was made up without knowing that Mr. Stewart's was £473,000. Making allowances for everything, the iron pipes can be delivered anywhere in the district for £5, or £5 5s. at the outside. The population, by the census just completed, is about 254,000, showing an increase of 42,000 in ten years, or 20½ per cent.—in other words, 2 per cent. per annum. There is no reason why it should not go on in the same ratio; and if that be so, it will be 360,000 in 1891. I am decidedly of opinion that no scheme should be sanctioned that does not look forward twenty years, keeping in view the great expense involved in going to a new district if you have exhausted the existing one. In fact, provision should be made for forty years. On the average, the present supply is about 7 million gallons a day, or 28 gallons per head; but in seasons of drought there is always a great deficiency, and the quantity falls far less than that. If the Pentland district is not supplemented, they cannot be expected to give more than 6 million gallons. The water supply in England and Scotland is very different. We cannot do with 30 gallons per head in Scotland. Glasgow takes 50 gallons; and though the commissioners there have tried often to bring down the quantity, they have never succeeded for any length of time. A bill has just been passed for Dundee to supply 50 gallons, and also one for Yorkshire giving the same quantity. Glasgow does not depend upon a large consumption for trade purposes. We have found that never more than 3 gallons are used for such purposes, the average supply for domestic use being 48 gallons. Applying that formula to the figures given as to the frequent deficiency and the increasing population, there is at present a deficiency of 5 million gallons per day. I calculate that in 1881 it will be 8 millions, and in 1891, 11 million gallons. If the population increases as I have said, and consumes the whole 50 gallons daily, the trustees would have to lay an additional pipe, which would give them another 12 millions. That would be all they would have to do, and it would cost only £140,000. The construction of the works where you have to impound the water cannot take less than five years, which would be the time required for the carrying out of the Heriot scheme, but then you must remember that it will only supply 9 million gallons. I should add, too, that at the end of ten or eleven years even this would be exhausted. Supposing the South Esk had been still available, it would have cost £500,000, and if the apparatus for filtration were gone into, perhaps £650,000; whereas for about £450,000 you can get the St. Mary's Loch scheme with all its advantages. As respects the simplicity of the works, the character of the district, the water itself, and the expense, it is in every point of view the most desirable scheme. The collecting-grounds are much superior to anything of the kind either in the Heriot or South Esk districts. The mountains forming the margin of St. Mary's Loch basin rise from 1700 to 2700 feet high. A large tract of ground within the basin is 1600, 1700, 1800, and 2000 feet high.

Mr. POPE: Irrespective of any other consideration, the higher the land the less likely it is to come under cultivation?

Witness: Much depends upon the geological character of the soil. The silurian district gives water of very pure character, and it runs off the land very rapidly. In the Loch Katrine works we had so little water that we were actually obliged to carry water down shafts and into the tunnel to lubricate the holes which we had to drill to blast the rock. Rain-gauges have been kept for many years in various parts of Scotland, and I have a record, supplied by the secretary of the Scottish Meteorological Society, extending from 1854 to 1870, and referring to twenty-nine stations, most of them having application to the district under consideration. 1870 was the driest year since 1853, with the exception of 1855; therefore it was important to ascertain what the smallest rainfall would be in the basin of St. Mary's Loch. Mr. Buchan has taken four different gauges. The per centage of difference varies from 21 to 29 per cent., but in 1870 it was less than the average of 21. The general average is 23½ per cent. There is always more rain on the Highlands than on the Lowlands, but it does not follow that it maintains a regular proportion. At a station in the district, 1750 feet above the level of the sea, the rainfall was 57½ inches. Reducing the whole of the figures, the average for 1870 varied from 34 to 57, the mean elevation being 1247 feet. The average in the driest year is 48 inches, but 36 inches is practically the available figure. We thus have 24 million gallons for the supply of the city, and 15 millions for compensation for the river.

Mr. POPE: You deal with the stream, not with individual interests.

Witness: You cannot deal with individual interests, for what one gets all must get. It makes a total of 39 million gallons a day to be dealt out of a total produce in a dry year of 62 million gallons. That is little less than two-thirds of the gross produce. Storeage has to be provided. During a drought of 120 days the produce of the stream would be 12 millions, and if we give 15 millions of compensation there would be a deficiency of 3 millions, so that the water must be impounded. I think 120 days drought long enough to provide for. The drought is longer where you are taxing the country with the whole water it will give, but there we are only taking two-thirds of the produce. In dealing with the natural produce of the district, I have been obliged to arrive at it inferentially in the absence of actual measurements. I have had to take similiar districts, and Loch Katrine is so identical that it is very remarkable they should resemble each other so closely. I have satistics of the rainfall at Loch Katrine from 1824 down to 1852.

Mr. POPE: Now, applying the whole mass of information you have accumulated to the present case, what do you say about the 15 million gallons of proposed compensation?

Witness: That they have got almost precisely the quantity of water given in the case of Loch Lubnaig. I can prove that the stream will fall as low as 3, 4, or 5 millions a day. Landlords like a regular supply, while millowners prefer an intermittent supply. We propose to deliver 10 millions a day constantly, and also keep up the amenity of the river for beauty, fishing, &c. Then we shall keep 5 millions in store as the "water bankers" of the millowners, so to speak, to have it when they want it. In all they might have 30 million gallons of motive power in the day, and would be better off than they are at present.

(To be continued.)

Miscellaneous News.

LEWES GAS COMPANY.

The Annual Meeting of the Shareholders was held on Monday, July 31, at the Mechanics Institution—Mr. HENRY BROWNE in the chair.

The CLERK (Mr. Hillman) read the minutes of the last meeting, which were confirmed, and the balance-sheet and report for the year ending the 24th of June, 1871. The balance-sheet showed an amount of capital and liabilities amounting to £23,304 3s. 5d., including a reserve-fund of £1250; while the property and assets amounted to £24,914 5s. 2d., including a sum of £509 2s., which had been disbursed as an interim dividend. There was therefore a balance of £1610 1s. 9d. available for payment of dividends or other purposes. The directors report set out the various items of receipt and expenditure upon the revenue account, showing a balance of profits of £1595 0s. 5d., and continued as follows:—

The balance of £1595 0s. 5d., as shown by the statement on the other side, together with the balance of the dividend account of last year, £15 1s. 4d., amounts to £1610 1s. 9d. Of this sum the directors certify that £1357 12s. may be divided among the shareholders, being at the rate of 8 per cent. per annum (3 per cent. having been already paid in part thereof), that £230 should be added to the reserve-fund, and that £22 9s. 9d. be retained on the dividend account. The reduction of the price of gas by meter from 4s. 7d. to 4s. 2d. per 1000 during the year was equal to a loss in the year's revenue of £369 8s. It will be very satisfactory to the shareholders to learn that the increase of consumption amounts to £147 16s. The reserve-fund, amounting to £1250, with the addition proposed to be made in the present year of £230, will stand at £1480. The directors have to regret that an outlay of £180 has been necessary to place the new gasholder and tank in working order. As this expenditure forms no part of the ordinary expenses of the year, it is proposed to charge it to the reserve-fund, the object of which is to meet such extra outlay as may from time to time occur. There have been twelve meetings of the directors since their election, of which Messrs. E. Morris, Robt. Crosskey, and John Bates have attended all; Messrs. Henry Browne, W. Farnes, J. L. Parsons, and Charles Parsons, eleven; and Mr. J. Hodgkin, eight. Mr. J. Saxby has not attended.

The CHAIRMAN, in moving the adoption of this balance-sheet and report,

referred to the profit which had been made from the sale of ammoniacal liquor which had long been a great trouble to gas companies, but now had a marketable value, and also stated that in viewing the works at Richmond he had examined the method adopted there in making an article called sulphate of ammonia. This was worth a considerable sum, and he thought this company could make it, and thereby considerably increase their revenue. The item for the new tank had been caused by the ground giving way and throwing the whole thing out of order. The subsidence of the land was now over, and it was working very satisfactorily.

Mr. E. MORRIS seconded the motion.

In reply to Mr. Green, it was explained that the whole of the reserve-fund was invested in the business.

Mr GODLEE, who said that as a consumer he had nothing to complain of, thought the directors had been premature in reducing their prices for gas from 4s. 7d. to 4s. 2d. per 1000 feet. No doubt 8 per cent. was a very fair dividend, but they had been accustomed to 9 or 10 per cent., and he thought considering their danger from new inventions they ought to have that, unless they had a large reserve.

Mr. BLAKER thought the charge for the new gas-tank should be placed to revenue account, and not charged against the reserve-fund. He would like to know whether this £180 was to be a matter of distinctive resolution, or what was to be done with it.

The CHAIRMAN said the first proposal had been to charge it to revenue account, but afterwards it had been thought better to charge it direct to the reserve-fund, which was provided to meet extraordinary expenses like this.

Mr. PARSONS, Mr. GREEN, and Mr. GODLEE having spoken shortly in reference to the accounts, Mr. LENNY reviewed them at some length, pointing out that while salaries had increased this year by £101, there had been £207 16s. 6d. less received for gas, &c., than last year.

Mr. GREEN wished to know what increase had been made in the salaries, and Mr. GOLDEE opposed the wish, on the ground that it was inexpedient, and that Mr. GREEN could see the books at any time he liked.

After a short discussion, during which the CHAIRMAN explained that the reason they lowered the price of gas was because the company was unprotected and unlimited, and the tendency of modern legislation was to give the management of such undertakings to municipal corporations, and therefore they thought their safest plan was to give the best article at the lowest possible price, the chairman stated that the increase in salaries had been £20 10s. 6d. to the collector, and £80 to the manager.

The resolution proposed by the chairman was then put and unanimously carried.

Mr. MORRIS proposed that a dividend of 8 per cent. be paid, less the amount of the interim dividend.

Mr. R. CROSSKEY seconded this resolution, which was carried.

The election of directors having taken place, the thanks of the shareholders were given to the board for their labours in the past year, in seconding which Mr. BLAKER drew attention to the unprotected state of the company, and urged strongly the desirability of obtaining an Act of Parliament duly incorporating them.

A vote of thanks was then passed to the chairman, who, in replying, pointed out that however desirable it might have been some 20 or 30 years ago to get such an Act, it would not be so wise now, because the House of Commons would attach such stringent regulations as to dividends and inspection to it. He thought it best to continue as they were.

The meeting then terminated.

CAMBRIDGE UNIVERSITY AND TOWN GASLIGHT COMPANY.

The Ordinary Half-Yearly Meeting of this Company was held on Thursday, July 27, at the Offices, Sidney Street—the Rev. Dr. PHELPS, chairman of the company, presiding.

The following reports were read:—

THE DIRECTORS REPORT.

The directors herewith submit to the shareholders a statement of accounts for the half year ending Midsummer, 1871, which accounts have been duly audited.

The profit and loss account for the half year shows a balance of £2931 9s. 3d., which, with the balance of £2086 14s. 1d. on the last year's account, gives, as the profit on the year's working, £5018 3s. 4d.

The directors recommend a dividend for the half year after the rate of £10 per cent. per annum on the consolidated stock, and after the rate of £7 per cent. per annum on the amount paid up on the new shares, payable on the 1st of August, free of income-tax.

The new gasholder has not yet been presented by Messrs. Balfour and Co., the contractors, to Mr. Hawksley, the company's engineer, for his certificate of acceptance. Mr. Balfour, is, however, now engaged in a thorough examination of the holder, and the directors have reason to expect that it will be ready for use by the end of the present month.

The shareholders will observe that, notwithstanding the payment of £2000 towards the cost of the new holder, during the year ending at Midsummer last, the balance of profit on the year's working appears to be more than enough to pay the full statutory dividends. It must be remarked, however, that, in view of an expenditure of £3500, the directors have been deferring much costly but necessary work, some of which could not be taken in hand until more storeage was provided, so as to admit of temporary cessation of manufacture of gas. Moreover, owing to the continued extension of the area of lighting, and the increased demand for gas, the time has arrived for a thorough examination of the older mains, substituting, in some cases, one large main for two or more small ones. The company's manager (Mr. Wood) is zealously employed in this useful work, and the directors have no doubt that the result will prove highly beneficial and satisfactory.

Some of the cost incurred in the substitution of mains, part also of that for enlarging the machinery and apparatus at the works, and about one-fourth of the price for the new holder, will be charged to capital account. The directors, therefore, will find it necessary to make a further call on the new shares, of which call due notice will be given.

The retiring director is Mr. Dennis Adams, who offers himself for re-election.

Cambridge, July 13, 1871. ROBERT PHELPS, Chairman.

THE MANAGER'S REPORT.

To the Directors of the Cambridge University and Town Gaslight Company.

Gentlemen,—I have to report to you that the last half-year's working has been generally satisfactory.

The business done in tar has not been very extensive, owing to the company having but lately entered into a contract for its sale.

The business done in sulphate of ammonia and fittings has been of the usual amount and character.

The illuminating power and purity of the gas have been kept up to the required standard, as shown by the daily testings, and corroborated by the public tester.

The renewal of some parts of the machinery, adverted to in my last report, has been carried out only to a very limited extent, so that considerable outlay on this account will be required. Also a renewal and extension of some parts of the plant are much needed, and plans for the same, which I have now in hand, will shortly be submitted for your approval.

Assuring you that the confidence placed in me encourages me to a strict attention to the company's interests, I am, gentlemen, your obedient servant,

W. WOOD, Manager.

The CHAIRMAN, in moving that the reports be received and entered on the minutes, said, with regard to the gasholder, the directors had been considerably disappointed in not having had it in their hands long before. In the report it was stated that they were disappointed last year in not having received it as expected for use during the winter. The same source of disappointment continued to be felt. It had not yet been given up to their engineer by Mr. Balfour, the contractor. He thought that upon the whole he might congratulate the shareholders upon the general state of the company and its financial condition, and on the comfortable relations between the directors and consumers. He believed there was a very good feeling on the part of the consumers, and he was sure that as far as the officers of the company were concerned, the directors had every reason to be satisfied. Nothing could exceed the courtesy and diligence of Mr. Wood, the manager, in his attention to the business of the company. The directors were doing everything they possibly could to make the Cambridge Gas-Works as good as could be, and he had no doubt that in a very short time they would be able to challenge comparison with any gas-works under like conditions in the kingdom. It had been his wish, from the first moment he was connected with them to the present time, to effect that state of things, and he had no doubt that they would be able to carry out what would be a credit to Cambridge, and would give complete satisfaction to the consumers. With regard to the holder, he might say that the directors had expressed to the contractor the dissatisfaction they felt at his want of promptitude, and that they had taken such steps as they thought necessary and right to secure the due fulfilment of his contract. There was still £1500 due to him, and he could not claim the last payment until the company had had the holder three months in use, and that period would be amply sufficient to test its soundness.

Mr. GIFFORD asked if there were any, and if so what, difficulties in connexion with the matter.

The CHAIRMAN said there were no difficulties, only that the holder had not been delivered over to them. Mr. Hawksley, the engineer, thought it was excellent as to its principles of structure, but it had not yet been tested in the usual manner. It had been filled with air by Mr. Balfour, this being the proper mode of testing in the first instance. It would not be prudent to fill it with gas, as danger might attend that operation, and a populous neighbourhood be imperilled. It was not the business of the directors to interfere till it was handed over to them; then it would be properly tested by their engineer, and he would say whether it was fit for their acceptance.

Mr. GIFFORD said September would soon be here, and now was the time for hurrying on the work.

The CHAIRMAN said that no one could be more anxious about it than he was, and everything that was possible was being done.

The resolution having been seconded by Mr. DENNIS,

Mr. S. PEED said there was an allusion in the report to the "statutory" dividends. He took exception to that word. The dividends they proposed were not statutory. He felt rather strongly on the subject, and he hoped that the time was not far distant when he should be able to put the matter before them in a very forcible manner, and that they would do what really was statutory.

The CHAIRMAN said he quite understood Mr. Peed, but he wished to call particular attention to the fact that the balance on the profit and loss account for this half year must not be considered its normal amount. It was quite exceptional. They had costly work on hand which must be gone on with. They must wait for two or three half years before they could really set forth the average state of the profits of the company.

Mr. GIFFORD said he should be glad if the directors could see the gas-works at Nottingham, on the duplicate system.

The CHAIRMAN said the directors had paid a visit to those at Yarmouth, which were on the same principle. There were two sets of works, everything being in duplicate, and this was admirable. There was no reason why they should not have similar advantages for the benefit of the gas consumers at Cambridge, and the directors hoped that this would be the case. It must be borne in mind, however, that the Cambridge Gas-Works were comparatively old to start with; and they could never expect to compete in external appearance of neatness with such model works as those of Nottingham. They hoped, however, to rival those or any others in all essential particulars.

The resolution was then put, and carried unanimously.

The CHAIRMAN moved—"That a dividend on the consolidated stock, after the rate of £10 per cent. per annum, and on the amount paid up on the new shares, after the rate of 7 per cent. per annum, be paid on the 1st proximo, free of income-tax," which was seconded by Mr. C. E. BROWN, and carried unanimously.

On the motion of Mr. PEED, seconded by Mr. DENNIS, the retiring director, Mr. Adams, was re-elected, and this gentleman having returned thanks,

Mr. BALLS moved, and Mr. PEED seconded, a vote of thanks to the chairman, which was put, and carried by acclamation.

The CHAIRMAN, in response, said he was very much obliged to his friends, Mr. Balls and the mayor, for the flattering terms in which, not only on this occasion, but on many others, they were pleased to speak of his services. He was fortunate in being associated with gentlemen who took the same lively interest in the duties of the direction as he did himself. It was due to them, as careful and conscientious men of business, that the affairs of the company would bear the scrutiny of the most critical observers. He and his friend the mayor differed upon one little point, as the mayor put it. There was, however, not much difference between them. They were both anxious to secure the interests of the two bodies—the shareholders and the consumers. His own feeling inclined a little towards the consumers, and that of Mr. Peed towards the company; at all events, he would put it in that way. His own strong feeling of interest was for the consumers, and he hoped that they would see the price of gas reduced to 3s. 6d. at no distant date. That, indeed, was his expectation. That the shareholders might receive their back dividends was also possible, and he hoped it might be some time or other accomplished.

The proceedings then terminated.

FIRST REPORT TO THE BOARD OF TRADE BY THE GAS REFEREES ON THE CONSTRUCTION OF GAS-BURNERS WITH REFERENCE TO THE PRINCIPLES OF GAS ILLUMINATION.

To the Lords of the Committee of Privy Council for Trade.

Gas Referees Department, 23, New Street, Spring Gardens, June 22, 1871.

The gas referees have the honour to submit to the Board of Trade the following report, which contains the results of their investigations of the principles which regulate the development of light from gas, and the application of those principles to the construction and use of burners, in the manner most advantageous and economical for the public.

Every improvement in the construction of gas-burners is equivalent, in its economical effects, to the discovery of a method of cheapening the manufacture and supply of gas; for it enables the public to obtain more light from the gas which they consume and pay for. By using good burners, instead of bad ones, consumers may obtain from 30 to 50 per cent. more light, while their gas bill remains the same.

The improvement of burners is also important as a measure of sanitary reform; for as by this means the required amount of light is obtainable from a smaller quantity of gas, the atmosphere of rooms and workshops is less vitiated. Not only is an unnecessary amount of heat avoided, but, in consequence of less gas being burnt, the pernicious products of combustion discharged into the air (viz., carbonic acid gas, the sulphur impurities, &c.) are equally diminished; so that the condition of the occupants of private dwellings, and still more of the workpeople employed in factories and other large establishments, is rendered more comfortable and more healthy than it could otherwise be. In fact, the improvement of burners is of itself an important means of diminishing the pernicious effect of the impurities in gas—the gradual reduction of which impurities to a minimum is one of the duties devolved upon the gas referees.

As stated in their report, dated the 3rd of May, 1869, the referees, in the course of their investigations relative to the choice of a standard burner, made and tested a large collection of burners of all kinds, obtained from the leading gas-fitting establishments and other quarters; and, in consequence of the great numerical preponderance of bad burners in the collection, they were led to inspect the gas-lighting arrangements in several large establishments in the City,

especially those in which, owing to the prevalence of night-work, an unusually large quantity of gas is consumed. The inspection fully confirmed the apprehensions which the referees had formed from their examination of the burners procured from the gas-fitting establishments. For example, in the offices of two of the daily newspapers (establishments which consume more gas than any others), it was found that the burners chiefly in use were so defective that they gave out only *one-half* of the illuminating power of the gas actually consumed; and several of the burners tested by the referees gave only *one-fourth* of the proper light of the gas. These facts, and many others which came to their knowledge, proved to the referees that "an enormous waste of gas prevails, with a corresponding pecuniary loss to the public;" and they consider it a matter of urgent importance that such facts should be made generally known.

The economy to the public arising from the use of good gas-burners, instead of bad ones, is so obvious as hardly to need remark. The gas-rental of London amounts annually to more than *two millions sterling*. Taking a very moderate estimate, upwards of *one-fourth* of this sum (£500,000 per annum) might be saved by the use of good burners. This is the saving which might be made in London alone; how much vaster the sum thus economised, if good gas-burners were to come into general use throughout England! In truth, the economy arising to the public from the use of improved burners is as large as can be produced for many years to come from any improvements in the manufacture of gas, or from the amalgamation of companies, by which the cost of supply will be so materially reduced. The question of burners, indeed, although hitherto so little considered or investigated, meets one at every turn in matters connected with gaslight, whether these be regarded as problems of science, or in the more widely useful and practical form, as a means of economy for the gas-consuming public.

On the Illuminating Power of Gas.

As a scientific question, the illuminating power of gas has given rise to much discussion; and there are several points of this kind, which, owing to their practical bearing, must be determined at the outset, in any satisfactory exposition of the most efficient and economical means and apparatus for obtaining a maximum of light from gas. The first of these questions is—Is the illuminating power affected by the quantity in which gas is burnt? In other words—Is it more economical to use small burners or large ones?

The doctrine that the light-giving power of gas undergoes variations according to the quantity in which the gas is burnt was first propounded, as the result of experiments, by Drs. Christison and Turner, of Edinburgh, in 1825, and subsequently by the late eminent gas engineer, Mr. King, of Liverpool, by MM. Audouin and Bérard, of Paris, and others; all of whom maintain that gas gives a larger proportion of light when it is burnt in large quantities than in small. The most recent experimentalist upon this question is Mr. Farmer, of America, photometric observer to the Manhattan Gas Company, who holds that the illuminating power of gas increases in a geometrical ratio as the square of the quantity of gas consumed. According to this doctrine (now known as the "Farmer theorem"), if 2 feet of gas give a light equal to 4, 3 feet of the same gas will give a light equal to (not 6, but) 9, 4 feet to 16, 5 feet to 25, and 6 feet will give a light equal to (not 12, but) 36. Although this theorem appears to have been accepted in America, it has found no supporters in this country. Nevertheless, the doctrine that the illuminating power of gas *does* vary (although in what ratio is not agreed) according to the quantity of gas consumed, appears to have taken firm ground on the Continent, as well as in this country and in America. As a practical question, it is important to determine whether the doctrine is correct.

In a case like this, the first and most natural suggestion is to inquire whether the observed variations in the illuminating power are not due, wholly or in part, to the mechanical apparatus employed for developing it. If 2 tons of identically the same coal do not, when burnt separately, give out the same amount of heat, is not the explanation to be sought in some difference in the mode of combustion? If 2 gallons of the same water, when weighed separately, do not show the same weight, must there not be some difference in the balances or in the details of weighing? In like manner, if 4 feet of gas do not give exactly two-thirds the amount of light which 6 feet of the same gas gives, is not the difference first to be looked for in the nature of the burners employed in the experiments? Not to take into careful account the influence of the burners, when testing the illuminating power of gas, is as great an oversight as if, in weighing, one were to make no examination of the balances, or as if an engineer were to take no account of the boilers he employed, and then, finding that a ton of coal in some instances raised a greater proportion of steam than when half a ton was used, were to jump to the conclusion that the heat-giving power of coal became greater, relatively to the quantity consumed, when a ton was used than when half that quantity was employed.

What a boiler is to coal and the generation of steam, so is a burner to gas and the development of light. One ton of coal in a locomotive of the present day generates as much force as 6 tons did 40 years ago, simply owing to the superior construction of the locomotive. In like manner, as regards the illuminating power of gas, there are good burners and bad ones. Moreover, as every scientifically constructed boiler is devised specially for a given amount of coal, by the consumption of which the boiler develops its maximum of power relative to the quantity of fuel used, so every well constructed burner is devised to consume a fixed quantity of gas; indeed, for every burner, whether good or bad, there is a certain rate of consumption at which the burner does more justice to the illuminating power of the gas than at other rates, whether greater or less. To disregard these considerations is to render experiments wholly useless and misleading.

First, as to good burners and bad ones. Take two burners each of which gives its maximum of light (*i. e.* does most justice to the gas) at the same rate of consumption; nevertheless, the light emitted by one of the burners may be much greater or much less than that of the other. Secondly, as to the misuse of the burners. Take a burner which does most justice to the gas when the rate of consumption is 5 feet per hour; then, if the rate of consumption be either increased or diminished from that point, the gas will, of course, give out less light in proportion to the quantity consumed than before.

Both of these facts, simple as they are, seem for long never to have been even suspected. The early experimenters relative to the illuminating power of gas wholly overlooked this fundamental point in the inquiry. This error was committed by Drs. Christison and Turner, who hence came to the conclusion that because one Argand burning 4 feet an hour gave more light than two precisely similar Argands consuming 2 feet each, that therefore gas gave more light when burned in the former quantity than in the latter. Upon similar grounds these experimenters might have maintained that because a ball fired out of a rifle with a charge of 3 drachms of gunpowder went farther and had more penetrating force than two smaller balls fired out of two similar rifles each with 1½ drachms charge, that therefore gunpowder had more explosive force, relative to its weight, when fired in the former quantity than in the latter. An Argand burner is fitted to consume a special quantity of gas of a given quality, just as much as a rifle is specially adapted for a special ball and charge of powder. And the same is true of every kind of gas-burner.

The proper regulation of the supply of air to the flame is the chief secret of developing a maximum of light from gas. The greater the quantity or the richer the quality of the gas, the more air is required, and hence the better will the flame bear contact with the atmosphere, for the greater is the quantity of matter to be oxidized or consumed by combustion. And it is important to observe that the greater the velocity with which gas issues from a burner, the greater is the supply of air to the flame—the more air is the flame brought in contact with. The stream of burning gas from the burner, rising through the (we shall say) quiescent atmosphere of the room, draws in the air upon itself, just as a rapid stream passing through a pool or lake disturbs the stillness of the pool, and draws in upon itself in eddies the surrounding water; and the more rapid the upward stream of gas, the greater the quantity of air thus drawn in upon the flame.

The important bearing which the above statements have upon any question connected with gas illumination is manifest at a glance. They illustrate the chief conditions which affect the illuminating power of gas; they show how great may be the variations of that illuminating power owing to the different kind of burners used, and also to the manner in which the gas is consumed even in the same burner. The subjoined statistics exemplify both of these points.

The experiments here given were made at intervals during the last two years, and the earlier experiments of the series were made without any reference to the theory or doctrine now in question, but simply in order to ascertain correctly and fairly the capacity of burners to develop the illuminating power or light-giving property of gas. The gas with which the experiments were made was common gas having an average illuminating power of 15 sperm candles, when consumed at the rate of 5 feet per hour in Sugg's London Argand No. 1. This Argand, burning at the above-mentioned rate, was taken as the standard in the experiments, and its light reckoned as 100. The other burners—namely, those experimented with—were made to consume gas at various rates, from 1 to 6 feet per hour; and the mode of computing their light with reference to the standard burner was the ordinary and simple one, as follows:—Suppose the tested burner gave a light of 40 per cent. (compared with the standard burner) when burning at the rate of 4 feet an hour, then, instead of 40, its light is stated in the fourth column as 50, because the standard was consuming 5 feet an hour against the 4 feet consumed by the tested burner. In like manner, if a tested burner gave a light of 60 per cent. (compared to the standard) when burning 6 feet an hour, then, instead of 60, its light is stated in the fourth column as 50, as it was consuming one-sixth more gas than the standard burner. On the other hand, if the tested burner consumed exactly 5 feet an hour, then the figures in the fourth column would be the same as those in the third, for in this case both the standard and the tested burner were consuming the same volume of gas.

First, let us give the results of the experiments with fishtail and bat's-wing burners:—

Fishtail Burners.

Pressure of Gas as delivered to Burner, in 10ths of an Inch.	Consumption of Gas in Feet per Hour.	Actual Illuminating Power. Sugg's London No. 1, at 5 Feet, being taken as 100.	Illuminating Power calculated to 5 Feet. Sugg's London as 100.
I.			
·1	1·1	6·8	31·2
·2	**1·7**	**12·2**	**36·0***
·4	2·5	17·6	35·3
·6	3·0	20·2	33·7
·8	3·7	22·0	29·0
1·0	4·2	23·0	27·4
II.			
·1	1·7	19·1	54·8
·2	2·6	30·7	59·6
·3	**3·1**	**38·4**	**62·0***
·4	3·6	44·3	61·6
·5	4·1	48·7	58·7
·6	4·6	57·5	56·0
·73	5·2	55·9	53·2
III.			
·35	3·0	29·7	49·6
·45	**3·3**	**34·3**	**52·0***
·57	3·8	38·1	50·2
·67	4·2	40·9	48·7
·77	4·6	43·5	47·3
·87	5·0	45·3	45·3
IV.			
·05	1·0	6·9	34·1
·17	**2·0**	**18·8**	**47·0***
·26	3·0	27·6	46·1
·61	4·0	30·9	38·6
·95	5·0	31·5	31·5
V.			
·3	1·4	4·8	17·4
·5	**1·8**	**6·8**	**19·0***
·65	2·0	7·2	18·2
·8	2·4	7·4	15·6
VI.			
·05	1·1	8·0	36·6
·1	1·5	16·6	53·7
·2	2·2	28·1	63·8
·3	2·8	39·2	63·7
·4	3·3	46·2	69·0
·6	**4·2**	**62·0**	**73·0***
·75	4·7	67·8	72·2
·85	5·1	71·9	70·5
·95	5·4	76·3	70·0
1·0	5·6	77·7	68·7
1·1	5·9	79·5	67·4

Bat's-wing Burners.

VII.			
·05	1·3	13·2	53·0
·1	2·2	16·4	74·8
·2	3·6	62·0	85·0
·3	**5·0**	**86·5**	**86·4***
·4	6·2	106·0	85·4
·5	7·2	111·2	79·4
·6	8·1	127·4	78·6
VIII.			
·1	2·0	28·7	70·7
·2	3·4	52·4	77·0
·3	**4·6**	**75·6**	**82·2**
·4	5·7	87·2	76·5
—	—	—	—
—	—	—	—

These experiments show at a glance what a difference the burner makes upon the light emitted by gas. The quality of the gas was, in each experiment, the same; yet how serious the difference in the amount of light given by the several burners—one of them (No. v.) giving at its best barely *one-fifth* of the light obtainable. But the point specially to be determined is, does the illuminating power of gas vary according to the quantity in which it is burnt, increasing with the rate of consumption? If the doctrine maintained by various experimentalists

* Those lines show the points of consumption at which each of the burners gives the greatest proportion of light from the gas.

in this country, and which Mr. Farmer carried to an extreme, were correct, we should find the burners giving more and more light, relative to the quantity of gas consumed, as the rate of consumption is increased; but these experiments show to demonstration that such is not the case. Instead of the gas giving more light as the rate of consumption is increased, it will be seen that, *in every case, there is a great point beyond which the light* DECREASES relatively to the proportion of gas consumed. In every case, too, this point lies below, and in most cases is *far below*, the maximum of ordinary gas consumption. Observe the turning-points, in the case of the different burners. In No. VII. the maximum of light given out is when the gas is burning at the rate of 5 feet an hour, beyond which point the more gas burnt the less is the proportion of light which it gives. In No. VIII. the maximum of light is at 4·6 feet an hour; in No. VI. it is at 4·2 feet; in Nos. II. and III. it is about 3 feet; in No. IV. it is at 2 feet; and in Nos. I. and V. at only 1¼ foot.

These experiments with bat's-wing and fishtail burners show conclusively that there is no foundation for the above-mentioned doctrine. But when we come to deal with Argand burners, we encounter results which tend to explain how the doctrine arose. As already said, the chief means of obtaining the maximum of illuminating power from gas is, to ensure an exactly adequate supply of air to the gas-flame; and, with Argands, this point is easily found, for it immediately precedes the stage of combustion at which the flame smokes—*i.e.*, when the air-supply becomes deficient, and a portion of the gas is not thoroughly consumed. Indeed, we may state as an absolute rule that *every burner gives its* OWN *maximum of light* (relative to the quantity of gas consumed) *when its flame is just upon the point of smoking.* With the bat's-wing and fishtail burners used in the preceding experiments, there was no rate of consumption at which the flame of any of them visibly smoked; and this holds good in regard to almost all bat's-wing and fishtail burners when used with common gas—*i.e.*, gas of from 12 to 16 candle power. But with Argands (owing to the glass chimney which encloses them, and regulates the air supply) it is always possible to increase the consumption of gas to such a point as will make the flame smoke; and hence every burner of this kind can be used in a manner which will give the full illuminating power of the gas, *so far as that is dependent upon an adequate air supply.* Now, as the common fault of Argands is that the gas issues under too great a pressure —*i.e.*, with too great a velocity, thereby bringing the flame in contact with too much air—it follows that the worse the Argand, the better will it become when a large quantity of gas is burnt in it; for the air supply, as regulated by the chimney, being nearly a fixed quantity, any excess in the air supply can be neutralized by increasing the quantity of gas consumed. But with all Argands, whether good or bad, the larger the quantity of gas consumed in them (short of smoking) the greater will be the proportion of light which they give from the gas. These facts, we repeat, tend to explain the origin of the erroneous and misleading doctrine, that the capacity of gas to give light increases with the quantity of gas consumed.

Here are the results of experiments made with four kinds of the Argand burner—the first (Sugg's London Burner, No. 1), one of the best that has ever been constructed; the second and third are ordinarily good Argands; and the fourth, one of the worst Argands that we have met with. The experiments with each burner were carried up to the smoking-point—beyond which point experiments are useless, as there is a manifest waste of gas by imperfect combustion :—

Argand Burners.

I.

Pressure of Gas as delivered to Burner.	Consumption of Gas per Hour.	Actual Illuminating Power, Sugg's London at 5 Feet being taken as 100.	Illuminating Power calculated to 5 Feet. Sugg's London as 100.
·05 inch	2·1 feet	5·4	12·7
·07 „	2·8 „	19·5	34·2
·1 „	3·3 „	34·1	51·6
·14 „	4·0 „	60·5	75·0
·17 „	4·4 „	77·0	86·1
·218 „	**5·0** „	**100·0**	**100·0**

II.

·02 „	1·6 „	2·0	6·2
·04 „	2·2 „	7·7	17·1
·07 „	2·9 „	19·7	33·1
·1 „	3·5 „	32·2	45·4
·15 „	4·5 „	58·9	64·8
·2 „	5·1 „	74·4	72·7
·22 „	**5·6** „	**89·1**	**78·8**

III.

·2 „	2·6 „	10·3	19·7
·3 „	3·3 „	22·4	33·8
·4 „	3·9 „	36·4	46·7
·5 „	4·4 „	49·2	55·7
·6 „	4·9 „	64·0	65·3
·7 „	5·4 „	75·6	69·4
·78 „	**5·8** „	**90·6**	**77·4**

IV.

·1 „	1·8 „	1·6	4·5
·2 „	2·7 „	7·8	14·3
·3 „	3·4 „	15·0	21·8
·4 „	4·2 „	21·9	26·0
·5 „	4·6 „	29·3	31·5
·6 „	**5·2** „	**34·7**	**34·3**

Here it is shown that the larger the quantity of gas consumed in Argands, short of smoking, the higher the proportion of light which they give from the gas. But it is to be noticed that even at this most favourable point of consumption there is a vast difference in the amount of light given by the different burners (a most important fact, the causes of which will be fully considered in the sequel). In short, then, these experiments with Argands, like the previous ones with bat's-wings and fishtails, show the paramount influence which the burner has upon the amount of light obtained from the gas. For while No. I. gives (what we may for the present call) the full illuminating power of the gas, which is taken as 100, Nos. II. and III. give a light only equal to 78, and No. IV. a light only equal to 34. In other words, the last of these burners, *taken at its best*, gives only one-third of the light which may be obtained from the gas by a really good burner.

The next experiments tend to show, by direct proof, that the illuminating power of gas remains the same, in whatever quantities the gas is consumed, provided that the right kind of burners be employed in the experiments. Every burner is fitted, and every scientifically constructed burner is expressly devised, for a certain rate of consumption; and to use a 6-foot burner with 3 feet of gas is as absurd as to use a 3-feet burner with 6 feet of gas. Hitherto sufficient attention has not been given to this matter (in the experiments of Christison, Farmer, and others, it was wholly overlooked); but in the construction of his new London Argands, Mr. Sugg has acted upon this right principle with great success—although, as will be seen from the next table, there is still room for improvement. The subjoined experiments were made with his series of London Argands, designed to burn respectively 4, 5, 6, and 7½ feet of common gas; and, as before, his No. 1 burner, consuming 5 feet per hour, is taken as the standard =100. The experiments were carried up to the smoking-point of each burner :—

Sugg's London Argands.

[These Argands are so constructed as to check the pressure of the gas "as delivered to the burner;" so that the pressure given in the first column is no indication of that under which the gas is actually consumed, which may be said to be *nil;* whereas with all the other burners tested in the preceding tables, the pressure of the gas "as delivered to the burner" is the same as at the point of ignition.]

As with the Argands previously tested, the experiments were carried up to the verge of smoking, at which point the burners give their greatest amount of light :—

Argand No. 0 (with 6 inch × 1¾ inch chimney).

Pressure of Gas as delivered to Burner.	Consumption of Gas per Hour.	Actual Illuminating Power. No. 1 Argand at 5 Feet = 100.	Illuminating Power calculated to 5 Feet. Standard = 100.
·12 in.	2·9 ft.	24·6	42·5
·2 „	3·8 „	64·6	85·1
·24 „	4·3 „	86·8	99·8
·31 „	**5·0** „	**108·5**	**108·5***

Argand No. 1 (with 6 inch × 1¾ inch chimney).

·16 in.	3·8 ft.	46·2	60·84
·2 „	4·2 „	72·25	86·0
·25 „	5·0 „	100·0	100·0
·29 „	**5·5** „	**118·6**	**107·6***

Argand No. 2 (with 7 inch × 2 inch chimney).

·22 in.	4·3 ft.	53·2	61·28
·27 „	4·9 „	74·9	75·75
·34 „	5·65 „	99·0	87·6
·42 „	6·65 „	118·1	88·8
·48 „	**7·2** „	**133·3**	**92·6***

Argand No. 3 (with 7 inch × 2 inch chimney).

·31 in.	5·5 ft.	92·16	83·7
·43 „	6·7 „	123·4	92·0
·5 „	7·2 „	135·2	93·2
·56 „	**7·8** „	**154·7**	**91·1***

Although there are some differences here, apparently due to some Nos. of the series being better constructed than the others, these last experiments (especially when taken in connexion with all the others) sufficiently indicate that, throughout the common range of consumption, there is no difference whatever in the illuminating power of gas; and beyond all question they demonstrate the erroneousness of the doctrine that the light-giving power of gas increases in a higher ratio than the quantity of gas consumed. In fact the smallest burners here give the best results; so that, in these experiments, the gas gives *less* illuminating power when burnt in large quantity than in small.

There is one point more, connected with the question of illuminating power relative to the quantity of gas consumed, which remains to be noticed. It will be seen that in the case of every one of the burners used in the preceding experiments, there is a point, in the rate of consumption, *below* which the proportion of light given by the gas falls short of the maximum of light which each of the burners respectively can give.† Indeed, in every case, we have purposely commenced our experiments with each burner at an unduly low (sometimes extremely low) rate of consumption, in order that this fact may be exhibited; and, arguing from this fact, the most cautious and moderate upholders of the doctrine that the illuminating power of gas is greatest when the gas is burnt in large quantities, maintain that, whatever be the rate of consumption, a fixed portion of the illuminating power of gas must always be lost, and that therefore it is advantageous to burn gas in large quantities. The explanation offered of this alleged fact is, that a *fixed* quantity of gas must be wasted, as regards its illuminating power—must be consumed simply to produce *heat* in sufficient amount to render the remainder of the gas incandescent and light-giving.

As to the amount of this "fixed" quantity of gas which has thus to be wasted, no statement of any kind has ever been offered; and the whole evidence in the matter proves that there is no such fixity of quantity at all, and consequently that the inference drawn from the supposed fixity (viz., as to the light-giving power of gas increasing in a higher ratio than the consumption) is quite unfounded. Indeed, this hypothesis as to the fixity of the quantity of gas (say a foot or half a foot) which is necessarily wasted, as regards illuminating power, however great or little may be the whole quantity consumed in the burner, is totally opposed to the ordinary laws of nature. To suppose that, when the rate of consumption is 4 feet, as much of the gas must be wasted, in order to produce heat enough to render the remainder of the gas luminous, as when the consumption is raised to double that quantity, is preposterous; for, obviously, there is twice as much gas to be raised to a state of incandescence in the latter case as in the former. In short, it might as well be maintained that the same quantity of coal is required to raise the steam, whether the boiler be large or small. Moreover, as shown in the various experiments already given, and as, indeed, is known to every one conversant with such matters, some burners, when consuming exactly the same quantity of gas, vary in the amount of light which they emit to the extent of 30, 50, and even 70 per cent., showing a corresponding loss or waste of the illuminating power, and thereby proving that the waste is anything but a fixed quantity.

In truth, in this case, as with all the variations in the proportion of light obtained from gas, it is simply a question of burners. No burners have as yet been devised for the consumption of gas in very small quantities, nor are they much needed. But, lacking such burners, let us make use of a rude apparatus for diminishing the air supply—viz., a metal disc placed above the upper end of the chimney of the Argand—and observe the result. The burner to which it was applied was Sugg's London Argand, No. 0, *the very best burner yet constructed,*‡ and which gives its maximum of light when burning at the rate of 5 feet per hour, the gas being of 15-candle power. The following table shows the extraordinary change made by the apparatus upon the light of this burner when consuming gas in small quantities :—

Pressure of the Gas as delivered to the Burner.	Consumption of Gas per Hour.	Illuminating Power *without Disc*, Calculated to 5 Feet per Hour, Compared with Sugg's London, No. 1, burning 5 Feet an Hour, as 100.	Illuminating Power *with Disc*, Calculated as before.
·064 inch. ..	1·65 feet. ..	7·36 ..	63·5
·075 „ ..	2·05 „ ..	15·2 ..	90·1
·1 „ ..	2·4 „ ..	30·7 ..	93·3
·2 „ ..	3·9 „ ..	88·3 ..	101·0
·25 „ ..	4·5 „ ..	103·9 ..	Smokes.
·27 „ ..	5·0 „ ..	109·6 ..	Smokes.

Here it is seen that in the initial experiment the application of the disc instantaneously increased the light from the gas *ninefold!* And in the second experiment, the application even of this rude apparatus sufficed to develop from only *two* feet of gas an amount of light proportionably greater than is obtain-

* Those lines show the points of consumption at which each of the burners gives the greatest proportion of light from the gas.

† Just as with bat's-wings and fishtails, there is a point of consumption *above*, as well as *below*, which the gas emits less than its maximum of illuminating power. Indeed, this is true of all kinds of burners, Argands included; although with argands the loss of light, above a certain rate of consumption, is due to smoking (imperfect combustion owing to a deficiency of air), whereas with naked burners it is due to an over supply of air.

‡ It is necessary to state that, notwithstanding the great care and skill with which Mr. Sugg constructs his burners, he has not yet succeeded in making them entirely uniform, so that some of these burners, although nominally alike, give appreciably different degrees of illuminating power.

able from ordinarily good Argands (or any other kind of burner) when burning at the usual higher rates of gas consumption; so that the loss of light when gas is burned in small quantities, so far from being a fixed and constant quantity, is shown to be simply owing to the burner, not to any variation in the light-giving power of the gas, but to the mechanical apparatus employed for developing that power. Just as (as best shown in bat's-wings and fishtails) a similar and equally great loss of light takes place when the consumption of gas is raised *above* a certain point, which varies with each burner.

Let us now summarize the results of the preceding experiments:—

1. In the case of the bat's-wing and fishtail burners, there is a point of consumption *above* which every increase in the rate of consumption produces a *decrease* of light relative to the quantity of gas consumed.

2. The point of consumption at which each of those burners gives its maximum of light, relative to the quantity of gas consumed, varies enormously—two burners (Nos. I. and V.) giving most light from the gas when the rate of consumption is only $1\frac{3}{4}$ *feet per hour*.

3. With Argands, on the other hand, the light from the gas steadily increases in a higher ratio than the consumption. In other words, the larger the quantity of gas consumed in Argands (up to the smoking-point), the greater the amount of light obtained relatively to the quantity of gas consumed.

4. Alike with Argands, bat's-wings, and fishtails, whatever be the rate of consumption at which the maximum of light is obtained—in other words, taking each of the burners at its best—there is nevertheless a striking difference in the degree of light obtained from the same quantity of gas, some burners giving a light equal only to 20, while others give a light equal to 60, 80, and 100.

5. The best kind of Argands (Sugg's London burners) give a nearly equal amount of light, relatively to the quantities of gas consumed, the experiments with them tending to show that, within the ordinary range of consumption, the illuminating power of gas remains the same.

6. Finally, even as regards very low rates of consumption—rates, indeed, at which gas is never burned for illuminating purposes—the application merely of a rude apparatus for regulating the air supply suffices to make only *two* feet of gas give a light equal in proportion to the greatest amount of light obtainable from the gas when consumed at any higher rate in a really good burner.

The establishment of the true facts of the case, simple and natural as they are, not only serves to remove a stumbling-block and perplexity from the path of science, but, as will be evident in the sequel, is of importance in the practical question as to what is the best mode of consuming gas with a view to obtain efficiently and economically its highest amount of illuminating power.

The Air Supply.

As already said, a due regulation of the supply to the flame is the chief principle to be observed in order to obtain from gas its full illuminating power. The air supply must be simply adequate to consume the gas—to give the exact quantity of oxygen required to consume the hydrocarbons and other vapour—and no more. This is a simple principle, but its practical application to gas-burners involves several points of a complicated kind. For example, although the flames of several Argands be equally brought to the point immediately preceding smoking (that is, to the consumption at which each of the burners gives *its* maximum of light from the gas), and where accordingly the air supply appears in each case exactly adequate, nevertheless some of the burners give much more light, relative to the quantity of gas consumed, than the others. This proves that the air supply (using the term in its simplest meaning) is not the only thing to be attended to. But if the matter be further investigated, it will be found that the causes of the difference in the light of these burners are really not separate from the air supply, but subsidiary matters of a delicate and very complicated kind connected with it. Although at first sight they may appear unconnected with it, they will be found (as we shall show) to be not separate influences, but only new proofs of the pre-eminent importance of the air supply in developing the illuminating power of gas from burners.

The air supply depends (1) upon the size and shape of the gas-flame—in other words, upon the extent of surface which the flame from any burner presents to the air. The larger the flame (*cæteris paribus*), the larger the air supply—*i.e.*, the greater the extent to which the flame is brought in contact with the atmosphere. But (2) the mere size of the flame does not of itself fix the amount of the air supply. Of two flames of equal size, the air supply to the one may be much greater than to the other; for, upon the same area of flame, the draught or inflow of air may be much greater in some cases than in others. Hence the air supply depends upon two causes—(1) the size and shape of the flame, and (2) the draught upon the flame.

The former of these causes needs no comment, it being obvious that the larger the surface of the flame, the more air will be in contact with it; but the latter—viz., the influences which increase or diminish the draught upon a given size of flame—calls for a word of explanation. These influences are of a twofold character; they are produceable either by enclosing the burner (as with Argands) so as to regulate the admission of air to the flame, or by the velocity with which the gas issues from the burner. In other words, they are dependent partly on the air supply, and partly on the gas supply; and the latter is the more generally important, as well as the less understood.

The draught or inflow of air upon a flame of a given size depends greatly upon *the velocity with which the gas issues from the burner*. With Argands there is a special means of regulating the air supply (viz., the chimney); but with all burners, whether Argands or naked burners, the velocity with which the gas issues has an important influence upon the air supply; and in the case of naked burners (bat's-wings and fishtails), this velocity of issue is, speaking roundly, the *sole* regulator of the air supply.

Every flame, by its heat, produces an upward current, which draws in upon its sides the surrounding air; but (the heat of the flame remaining the same) the greater the ascending velocity of the gas, the greater is the draught made by the flame, and the more air is drawn in upon it. To use a simile previously employed, a gas-flame rises into the air like a rapid stream entering or passing through a quiescent pool, producing eddies, setting in motion and drawing in upon its sides in currents the surrounding water. The more rapid the entering stream, the greater the currents and eddies—the watery draughts, so to speak—which it makes in the pool; and these inflowing currents not only play upon the sides, but tend to mingle with the stream itself. Thus there are two constant and unavoidable causes of draught or air supply to a gas-flame:—Firstly, the ascending power or velocity of issue which gas possesses, even when unignited, owing to its being lighter than the air; secondly, and chiefly, the fact that it is a *flame*—a source of heat—producing a partial vacuum, which the surrounding air flows in to fill up.

But there is another and *avoidable* cause of draught or air supply—namely, the extrinsic velocity of issue from the burner which gas acquires from the pressure in the service-pipes—a point which, as will appear in the sequel, is one of the greatest practical importance in the whole question of gas combustion for illuminating purposes.

There is a striking difference of appearance between gas-flames and what may be called *natural* flames—*e.g.*, of burning coal or of a candle. The latter flames are more solid—they have less blue and more white than gas-flames. This is owing, in the first place, to there being more carbon in these natural flames than in gas. Take the case of a candle, or of the flames from coal burning in a grate. In both of these cases, the whole of the light-giving vapours are consumed in the flame; whereas in gas, a large portion of the light-giving vapours of coal are lost, being withdrawn by the condensing apparatus of the gas-works. It is only the *permanent* vapours of coal that constitute gas, the word gas, in fact, meaning a permanent vapour—*i. e.*, one which does not condense under ordinary circumstances. But a large proportion of the illuminating elements of burning substances condense readily, and therefore cannot be used as gas. In an oil-lamp or a candle, the *whole* of the illuminating vapours of the oil and the tallow go to form the flame; but in gas a large portion of the illuminating constituents of the coal is withdrawn by condensation in the form of tar, naphtha, &c.; for as these vapours condense at the ordinary temperature of the air, they would, if left in the gas, become solids as soon as they cooled, and thereby choke the pipes.

This is one cause of the difference between natural flames and gas-flames; the former are produced by the whole illuminating vapours of the burning substances, whereas in gas all the non-permanent vapours are withdrawn, and the light is due only to the permanent vapours yielded by the coal.

But there is another matter which has to be taken into account. All *natural* flames rise into the air without "pressure," and simply by the twofold ascending power which they possess (1) from the lightness of the illuminating vapours given off from matter by the application of heat, and (2) from the additional lightness which those vapours acquire from being *burnt* (whereby their temperature and consequently sparseness are vastly increased). Hence the velocity, or upward rush, of natural flames is at a minimum, so that they come in contact with the atmosphere to the smallest extent possible. But with gas-flames the case is different. The gas issues from burners under more or less pressure,* so that the flame rises into the air not merely owing to its intrinsic lightness, but from a pressure from below, which artificially increases the velocity of issue of the gas. This "pressure," as already said, is owing to the pressure which the gas has in the service-pipes being allowed to pass into the burner. Moreover, the great majority of burners are so faultily constructed that a high pressure is actually *necessary* in order that the gas may be passed through the orifices of the burner in sufficient *quantity* as regards Argands, or with sufficient velocity to give the desired *shape of flame* in the case of bat's-wings and fishtails.

How Pressure affects the Air Supply.

"*Pressure*"—or rather the velocity of issue due to it—has an important influence upon the light-giving power of gas. Let us see, then, how the pressure is produced, and how it acts upon the flame. Gas in the service-pipes always has (and in order to provide an adequate supply always must have) some degree of tension or pressure, varying from about half an inch during the day to 2 inches after sunset; and in proportion as the gas-tap is opened, more or less of this pressure passes through and increases the velocity with which the gas issues from the burner. According to their structure, burners, with the same rate of pressure, will consume different quantities of gas. But with any given burner an increase of pressure is indispensable to increase the rate of consumption—in other words, the quantity of gas emitted from it. When we want to burn more gas, we open the tap more widely; thereby we allow a larger portion of the pressure of the gas in the service-pipes to act upon the burner, so that, although the orifices of the burner of course remain the same, a larger quantity of gas is passed through them.

Now for the effect which this "pressure" produces upon the air supply to the flame. As the pressure is increased more gas issues from the burner, and consequently a larger supply of air is needed for the flame. Hence it may be thought that, although the increased velocity (due to the increased pressure) with which the gas issues from the burner augments the draught upon the flame, this will be balanced by the additional quantity of gas to be burnt, which of course requires an addition to the air supply. But this is not the case, for the pressure increases in a much higher ratio than the quantity of gas consumed; consequently the draught or air supply (which is augmented by the pressure) is increased to a greater extent than the quantity of gas to be burnt. As is well known, the discharge of gas from the burner increases, not *pari passu* with, but only as the square root of the pressure. For example, say that a burner consumes 3 feet of gas an hour with a pressure of 1-10th of an inch; then, in order to raise the rate of consumption to 4 feet, the pressure will have to be raised to 1·66-10ths of an inch; if the consumption be increased to 6 feet, the pressure will be 4-10ths of an inch; and if the consumption be raised to 9 feet an hour, the concomitant pressure will be 9-10ths of an inch. So that, while the consumption is only *trebled*, the pressure required to give this increase of consumption is *ninefold*. In this way the gas-flame is brought in contact with more air than it is able to bear without loss of illuminating power, as a simple trial will show. Take a bat's-wing or fishtail burner—say, one which does most justice to the illuminating power of the gas when burning at the rate of 5 feet an hour; then gradually open the tap till the consumption rises to 6, 7, or 8 feet an hour. In spite of this increase in the quantity of gas consumed, there will be very little (certainly no corresponding) increase in the size of the flame, and comparatively little increase in its illuminating power. This serves to explain the great influence which pressure has upon the illuminating power of gas—beyond a certain point ever tending to destroy it by increasing the draught or air supply in greater proportion than the quantity of gas to be oxidized or consumed.

Other Points.

Besides this question of pressure, there are two subsidiary points connected with the air supply which must be noticed. Firstly, the burner ought to be so constructed that the supply of gas to all parts of the flame is *equal*; for, otherwise, some parts of the flame will smoke, while the other parts are burning properly. As already stated, the maximum of light obtainable from any burner is when its flame is just upon the point of smoking; but if some parts of the flame smoke before the others, it is obvious that there will be a waste of gas at some parts of the flame while the other parts are burning at their best.

Secondly, it is important that the gas should be supplied to the burner in an even and steady current. This is necessary partly to attain the first-named object—namely, an equal supply of gas to all parts of the flame; but it is also necessary for another reason—namely, that if there is any swirl in the gas-stream as it issues from the burner, this swirling motion injuriously affects the flame—apparently by increasing the draught upon it. Indeed, the "roaring" of a gas-flame is due far more to the eddying or swirling motion of the stream of gas as supplied to the burner than to a mere excess in the quantity of gas consumed. This phenomenon is easily shown with fishtail burners, especially when the gas-tap or cock is placed close to the burner, in which case the flame frequently "roars" when the tap is only partially opened, yet ceases to roar when the tap is opened fully; the explanation being that in the former case a swirling motion is imparted to the gas owing to the position of the valve or tap, which ceases when the tap is fully opened, although more gas is then supplied to the burner.

Effect of the Air Supply on the Illuminating Power.

The numerous and intricate questions connected with the development of the illuminating power of gas have hitherto been examined in so inadequate a manner that little certainty has been attained. A gentleman of reputation as a chemist and scientific inquirer, recently remarked to the referees that the more any one experimented with gas-burners, the more he became aware how little is yet known upon the subject. In the preceding portion of this report, the referees believe that they have done much, by carefully conducted experiments, to remove the prevailing uncertainty, and to determine accurately the leading principles of gas combustion with reference to illuminating power. Indeed, in its most important aspect—namely, *practically, and as a matter of economy*—

* In some of the newest and best-constructed burners, means are taken to reduce the pressure of the gas from the service-pipes, so as to allow the gas to burn under nearly the same conditions as *natural* flames; but, with this exception, gas is always consumed *under pressure*. Indeed, with all kinds of naked burners (bat's-wings and fishtails) some degree of pressure is indispensable to give the proper shape and steadiness to the flame.

the referees believe they are in a position to solve the question determinately. But, as a matter of science, there are still some points upon which they can as yet speak only suggestively.

They have shown, as a matter of fact, the effect of pressure and air supply upon the illuminating power of gas, but there is still some uncertainty on the scientific question as to how this effect is produced. So far as there is any opinion on this point, it is said that the great loss or waste of illuminating power from the use of bad burners is occasioned by the gas being rapidly consumed, and that, in order to obtain the highest amount of illuminating power, the gas should be consumed in such a manner as to keep the gaseous atoms "as long as possible" in a state of incandescence. As a matter of fact, this opinion is incorrect; for, as shown in the experiments given *infra*, up to a certain point the illuminating power of gas is increased by quickening the rapidity of the combustion. Moreover, theoretically, the above-mentioned opinion is open to the objection that, if the gas be thoroughly consumed, the more rapid the combustion the more *intense* will be the light emitted, though the *size* of the flame be less. Just as a pound of coal, if thoroughly consumed, gives out the same amount of heat whether the rate of combustion be slow or rapid. If the coal be consumed in one minute, the heat emitted during this minute will be twice as much as it would be in the same time if the combustion were to last for two minutes. In like manner, if rapidity of combustion were the sole cause of difference, it may safely be maintained that though a gas-flame will be smaller in proportion as the combustion is rapid, its light will be proportionally more intense; so that its illuminating power (which depends upon the volume *plus* the intensity of the flame) would in both cases be the same. The experiments of the referees, however, show that the increased *intensity* of the light of a gas-flame, when rapidly consumed by an excessive draught or air supply, is not sufficient to compensate for the decrease in the *size* of the flame. And, upon the natural law above stated, this result appears to the referees to demonstrate that the diminution of illuminating power is not due merely to the more rapid combustion of the carbon particles, but to an alteration in the other conditions under which the combustion of those illuminating particles takes place.

The size or height of gas-flames is notably diminished by increasing the draught or air supply. An Argand burner, without its chimney, gives a tall flaggy yellow smoking flame. Put on a chimney (thereby increasing the draught), and immediately the flame is shortened, but becomes brighter; increase the length of the chimney, and the flame is still further shortened. The explanation is, that the gas is more rapidly consumed; so that, instead of rising as at first to (say) 8 inches, the flame rises only to 5, 4, or 3 inches; in short, if the gas is consumed twice as rapidly—*i. e.*, in half the time—the flame will be only half as tall as at first, the combustion of the gas being concentrated or condensed (so to speak) into a smaller space. Nevertheless, it might be expected that the shorter flame would give out as much light as the taller one; for the quantity of illuminating matter consumed is in both cases the same, so that the shorter flame should be twice as bright (the intensity of the light should be twice as great, relative to the size of the flame) as the taller one. It is difficult, if not impossible, to experiment successfully with naked burners in a case of this kind, for the only way in which variations in the air supply can be made with naked burners is by altering the size of the flame and the pressure at which the ga is consumed; for, such burners being unenclosed, there is no separate means of increasing or diminishing the draught upon them from the surrounding air But with Argands the regulation of the supply of air can be made in any way that is desired, by altering the size of the chimney, and also the apertures by which air is admitted at the bottom of the burner.

Let us take an Argand, and see how the size of the flame, and also its illuminating power, are affected by varying the draught or air supply by means of the chimney. Take Sugg's London Argand No. 1, consuming 5 feet an hour of 16-candle gas. Without the chimney, we get a waving yellow flame about 8 inches in height, and occasionally smoking. The gas, in fact, extends itself upwards until, by the size of the flame, it comes in contact with the air to the requisite extent to produce entire, or almost entire, combustion. Put on a chimney, of the most suitable kind for this quantity and quality of gas, and the height of the flame is at once *reduced by one-half*, nevertheless the illuminating power of the flame is *increased by one-half*. How is this? If, as is held, a slow rate of combustion were the best means of developing the illuminating power of gas, the tall flame which rises from an Argand without the chimney ought to give the maximum of light. But, as already stated, the fact is otherwise; for when the chimney is placed on the burner, and the combustion of the gas proceeds much more rapidly than before, the illuminating power of the flame is largely increased. The size of the flame is diminished by one-half, yet its illuminating power is one-half greater. The explanation of this evidently is, that in the latter case the brilliancy of the flame, owing to the intensity of the combustion, is so much increased as to far more than compensate the diminution in the size of the flame. Instead of a tall dull yellow flame, about 8 inches in height, we have a flame less than 4 inches high of brilliant white, which gives much more light than the taller flame. The cause of the shortening of the flame is the more rapid combustion of the gas, owing to the increased draught or air supply produced by the use of the chimney. Being consumed in half the time, the gas-flame rises to only one-half its former height; but the increased intensity of combustion (in other words, the higher temperature at which the gas burns by obtaining an increased air supply) produces a greater amount of light from the shorter flame than from the taller one. Hence it is manifest that rapidity of combustion, so far from occasioning a loss of light, may—and in this case does—greatly increase the illuminating power of burning gas.

But if, continuing these experiments, the draught upon the flame is still further increased, we obtain opposite results. We have seen that, when a suitable chimney is placed upon the Argand, the gas-flame, though reduced one-half in size, gives about one-half more light than before; but, if we still further increase the draught by using taller chimneys, a further diminution occurs in the size of the flame, which is not compensated by the increase of its brilliancy. And the explanation of these opposite results will, we think, throw an important light upon the real cause of the startling diversity of illuminating power obtained from gas when consumed in different burners and under different conditions.

In the above-mentioned experiments with the flame of an Argand burner, without a chimney and with it, we employed a suitable chimney, as in No. 5 of the subjoined experiments. But now, excluding the chimneyless flame, let us confine the experiments to the flame of an Argand burner in its ordinary condition—that is to say, with a chimney. Again take Sugg's London Argand No. 1, burning at a fixed rate of consumption; and suppose, in the first case, that this rate of consumption suffices to give a flame which smokes and "tails over" the top of a chimney 6 inches by 1¾ inch. Then use a 6 × 2 chimney; the effect is to shorten the flame, although in the burner used in the following experiments the smoking did not wholly disappear.* Next use a 7 × 2 chimney, and the flame is still further shortened; with an 8 × 2 chimney, the flame is shortened still more, and so on. Now let us note the accompanying changes in the height of the flame, and in its illuminating power, at the same time observing the changes in the *intensity* of the flame, by placing in front of the flame a metal plate with a horizontal aperture about half an inch in depth, which is raised or lowered in each experiment so as always to be on a level with the brightest part of the flame, the rest of the flame being hidden by the metal plate. The following were the results obtained—the experiments being made in an Evans photometer—the highest illuminating power of the entire flame, and also of the narrow band of flame, being each taken as 100. And to make the table complete, we include in it also an experiment with the tall flame from the Argand without the chimney, in which case the rapidity of combustion is at its slowest point:—

Sugg's London Argand, No. 1, consuming 5 Feet per Hour of 16-candle Gas.

Experiments.	Size of Chimney.	Height of Flame.	Illuminating Power of the Entire Flame.	Varying Intensity of the Narrow Band of Flame.
No. 1	Without chimney	8 inches	66	29·3
„ 2	6″ × 1¾″	Smoked	98	82·0
„ 3	6″ × 2″	Smoked slightly	98·2	82·6
„ 4	6½″ × 2″	4 inches	98·7	83·7
„ 5	7″ × 2″	3·6 „	100·0	90·0
„ 6	7½″ × 2″	3·25 „	99·2	92·9
„ 7	8″ × 2″	3·0 „	96·7	94·7
„ 8	9″ × 2″	2·75 „	92·1	97·1
„ 9	10″ × 2″	2·6 „	87·9	98·9
„ 10	11″ × 2″	2·5 „	84·57	100·0

The *actual illuminating power* of the band of flame (·54 inch deep), and also of the whole flame, was respectively as follows:—

Experiments.	Whole Flame.	Band of Flame.
1	66	10·36
2	98	35·04
3	98·2	35·28
4	98·7	35·76
5	100·0	38·44
6	99·2	39·69
7	96·7	40·44
8	92·1	41·47
9	87·9	42·25
10	84·57	42·77

It is difficult to determine, with the nicety requisite in a case of this kind, the exact height of the flame of the Argand burner; yet it is manifest, from the results above recorded, that the rapidity of combustion, so far from necessarily reducing the illuminating power, is, within certain limits, indispensable to develop the maximum of light from a gas-flame. The mere duration of the illuminating carbon-atoms in a state of incandescence is not of itself capable of producing a maximum of light; for, as above shown, up to a certain point an increase in the rapidity of combustion serves to increase the illuminating power, doubtless owing to the higher temperature of the gas-flame so produced. On the other hand, beyond this point, the decrease in the size of the flame, owing to an increased draught upon it, is not compensated by the augmented brightness of the flame. For example, when the *entire flame* gives its highest illuminating power (100), its height is 3·6 inches, and the light from the *band of flame* is as 90; and when the height of the flame is reduced to 2·5 inches, the light from the band or brightest part of the flame is as 100; in other words, the size of the flame is reduced 23 per cent., while the brightness of the flame increases only to the extent of 11 per cent. Hence it appears that, as in each case the amount of gas consumed is the same, the gas burns under less favourable conditions when the draught upon it, and consequently the height or size of the flame, is either above or below a certain point. The illuminating power of a flame is due to its size *plus* its intensity; in the first five testings given above, the flame gains in illuminating power, though its size is reduced; but in the five subsequent testings, the further reductions in the size of the flame were not compensated by its increased brilliance. The explanation of the results obtained in the first five testings is that the gas was burning at first at a lower temperature than it afterwards acquired, and partly wasted, as shown by the smoking; but what explanation is to be given of the subsequent testings, in which the whole of the gas appeared to be thoroughly consumed, yet the illuminating power decreased? How is it that the increased draught upon the flame produced this effect? What is the true cause of the loss of illuminating power when a gas-flame is exposed to an amount of air-supply greater than what is necessary to produce complete combustion of the gas?

As is well known, the Bunsen burner, in which air is made to mingle with the gas before the point of ignition, gives a pale blue or violet flame which is almost lightless. But in proportion as the mingling of the air with the gas is diminished, by closing some of the holes in the stem of the burner, the flame becomes white and light-giving. A commingling of air with gas enormously diminishes, and may entirely destroy, the light-giving power of gas. And it may be inferred, *à priori*, that even when the gas is burnt pure, an over-supply of air to the flame, by a sharp draught upon it, will tend to produce a similar effect, although in a much less degree. But in what manner is this effect produced?

First, take the case of a Bunsen burner. The air which mingles with the gas before the point of ignition, and which (so to speak) is burnt along with it, contains 73 per cent. of nitrogen, which is a non-luminous, indeed incombustible, body; and the result is that the gas-flame, being diluted with this incombustible body, cannot possibly attain the temperature which it would possess if burnt by itself—part of the heat of the burning gas being taken away in heating the intermingled nitrogen. But oxygen when in excess plays a similar part; for that portion of the oxygen of the air which is not needed to produce the combustion of the gas cannot burn, and simply dilutes the gas with a non-luminous body, which abstracts a portion of the heat generated by the burning gas. Hence, the flame of a Bunsen burner is, or may be, diluted by two non-luminous bodies—namely, by the whole of the nitrogen of the air admitted into the stem of the burner, and also by that portion of the oxygen of the air which is not needed to produce combustion of the gas, yet which, under the influence of "pressure" and draught, may commingle with the flame, not only of the Bunsen, but of every kind of burner. The consequence is, that the two non-luminous (and in this case incombustible) diluents—the nitrogen and the excess of oxygen—mingling in the flame, are heated by abstracting heat from the burning gas; so that it seems obvious that the gas-flame cannot acquire the high temperature which it would otherwise possess. The damaging effect of an influx of air upon, or indeed into, burning gas, may readily be seen in the case of the large unprotected gas-flames in front of butchers shops, where every gust of wind striking the flame so reduces its temperature that a large portion of the gas at once ceases to be consumed, and passes off in dense smoke.

The production both of heat and light is due to a vibratory motion of the atoms of matter in a state of combustion. By raising the temperature of a body which is only giving out heat, its molecular vibrations may be increased till it gives out light also. And the greater the heat—in other words, the more rapid and intense the vibrations of a luminous body—the greater will be the amount of light which it emits. This principle has of late years been most clearly and abundantly shown by the experiments connected with spectrum analysis; even the least combustible substances being made to give spectra, or rays of light, when their temperature is raised to a very high point (as by means of the electric spark); and a body which at first gives out only a few lines or bands of light, by increase of temperature gives out more and more until it gives a continuous spectrum.

* In their *Instructions to the Gas Examiners*, the referees direct that when the gas slightly "tails over" the standard Argand burner with a 6 × 1¾ inch chimney, a 6 × 2 chimney should be used. An objection has been made that this change cannot possibly make any difference, inasmuch as the height of the chimney remains the same, while the opening at the bottom for the admission of air remains likewise the same. But in making this objection, the fact has been overlooked that by *widening* the chimney the flame of the burner occupies proportionately less space within the chimney than before, so that the heated air can escape more readily from the top of the chimney, and also has fuller access to the sides of the flame, producing more thorough combustion.

Upon this principle it may be inferred, *à priori*, that the higher the temperature of burning gas (in other words, the more intense the combustion), the greater will be the amount of light which it emits. And from the instance of the Bunsen burner, the same inference is practically arrived at from the opposite direction—namely, from the fact that the Bunsen flame, which is almost lightless, must, from the large intermixture of incombustible air, have a lower temperature than if the same quantity of gas could be burnt pure (*i.e.*, without any intermixture of air) within the same space or size of flame.

The flame of the Bunsen burner has hitherto been regarded as the hottest of all gas-flames. But this is not correct; for, in repeated experiments, we have seen a platinum wire melt in the blue part of bat's-wing and fishtail flames (it is almost impossible to make the experiment with Argands owing to the chimney), whereas the same wire did not melt in any part of the Bunsen flame. The special advantage of the Bunsen burner is that it gives a smokeless flame, and also that, by the intermixture of air, the gas is consumed within the smallest possible space; and *cæteris paribus*, the smaller the flame in which a given quantity of gas is consumed, the hotter will be the flame—more gas being burnt in the same space. At the same time, as already said, it seems obvious that owing to the intermixture of air with the gas, the flame of the Bunsen burner cannot possess as high a temperature as would be the case if an equal quantity of gas could be burnt pure in an equally small flame. The Bunsen burner consumes the gas in the smallest possible space—thereby concentrating the heat developed by the burning gas; but, on the other hand, the intermixture of air appears in some respects to alter unfavourably the conditions of combustion.

At an early stage of our experiments with burners, it was incidentally observed that the heat which Sugg's London Argands gave out to a person standing on a level with or a little below them, was greater than that of inferior burners; and, to test the accuracy of this impression, a thermometer was placed at a lateral distance of 6 and 12 inches from several different burners consuming the same quantity of gas, and also suspended 18 inches above them. The temperature of the room being about 55° Fahr., the results obtained were as follows:—

Kind of Burner.	Thermometer at a Distance of 6 Inches laterally.	12 Inches laterally.	18 Inches above.*	Illuminating Power.
London Argand No. 1	70·0° F.	64·0° F.	170°—200° F.	100·0
Sugg-Letheby	64·4° „	62·6° „	220°—250° „	85·6
Bad Argand	59·5° „	58·0° „	200°—220° „	34·5
No. 8 Fishtail	60·5° „	57·5° „	115°—125° „	89·5
No. 4 Fishtail	61·7° „	59·5° „	200°—210° „	62·7

These experiments, rude as they are, bring into notice a fact of general interest, and of great importance as regards the combustion of gas. They show a relation between the lateral radiation of heat from burners and their illuminating power. If any substance is consumed at a comparatively low temperature, its heat will simply ascend, the heat-rays so produced having little power of radiation or penetration, and the heat of the burning body going upwards in the form of a narrow column of hot air. But, as the intensity of combustion is increased (in other words, the hotter the flame), the radiating or penetrating power of the heat-rays will be augmented, they will extend to a greater distance laterally. Having previously arrived, from *à priori* reasoning, at the opinion that the hotter the flame of any burner, the greater will be its illuminating power, we find a strong corroboration of this opinion in the result of the above experiments, which show that the burners which give the best light, give also the largest amount of lateral heat, this lateral radiation indicating the intensity of the combustion, or, in other words, the heat of the flame. Unfortunately, no pyrometer has yet been invented for correctly ascertaining the differences in the temperature of gas-flames; but the above experiments and reasoning may, we think, be accepted *ad interim* as proving that the hotter the flame from any burner, the greater will be its illuminating power.

In all flames like those of gas, of a candle, or a match of wood or paper, a portion of the flame is blue. And this blue portion is always at the bottom of the flame. Any one who examines a burning candle will also observe that there is a peculiar band of very bright blue forming the outermost rim of this lower part of the flame. And if a burning spill of wood or a paper match be examined, it will be seen that this bright-blue part of the flame is strongest (not only at the bottom, but also) at the point nearest to the unignited part of the match—*i.e.*, at the point where the substance first takes fire. Doubtless the blue and almost lightless part of all flames is produced from the combustion of hydrogen (which ignites more quickly than the carbon), and the bright blue rim edging this under part of the flame is due to carbonic oxide. By repeated experiments, also, we have found that the blue part contains within it the hottest point of the flame.

Lastly, as to the constitution of the upper white portion of gas-flames. This upper portion may be said, speaking roundly, to be the only portion of the flame which gives light. How is it composed? The fact of gas-flames smoking shows that some portion of gas may pass through the whole of the flame without being perfectly consumed; and the upper portion of the flame manifestly consists of gaseous atoms which have passed through the lower blue portion of the flame unignited, or else which acquire an increased temperature as they ascend.

As the illuminating power of gas is due to the incandescence of carbon, it appears evident that, while the free hydrogen burns in the under part of the flame, the hydrocarbons burn chiefly in the upper part; and the intensity of their combustion is aided by the great heat generated by what may be called the furnace of hydrogen below.

The preceding statements serve to explain the damaging effect of "pressure" upon the illuminating power of gas-flames, which appears to be due to its cooling the burning gas by increasing the draught upon the flame, thereby bringing an excessive quantity of cold air upon the sides of the flame. Moreover, the draught so produced not only brings too much air in contact with the surface of the flame, but tends to *mingle* the inflowing air with the gas; thereby still more reducing the temperature of the flame, and consequently diminishing its illuminating power. Indeed, when the pressure is unusually high, it seems not impossible that the cooling effect of the intermingling air, and the velocity of the ascending gas, are so great that some portion of the gas may pass off wholly unconsumed. At first sight, it is true, such a conjecture appears highly improbable; because, in cases of imperfect combustion, we naturally expect to see the upper edges of the flame smoking. But the loss of light when an extreme rate of pressure is employed is so very great, that it, at least, suggests the conjecture whether some part of the gas does not actually escape wholly unconsumed. It is a difficult matter to ascertain by correct proof whether this is so or not; but experiments are in progress which may throw light upon this point. As already stated, we have ascertained that the best burners give out more heat *laterally* than bad burners do; and by enclosing, in a suitable apparatus, some very good and very bad burners, or the same burners under high and low rates of pressure, it will be possible to determine whether the *total heat* given out from each, when consuming the same quantity of gas, is alike. If totally consumed, the same quantity of gas must generate the same amount of heat; and if any of those burners generate a less total of heat than the others, it will be demonstrated that in such cases a portion of the gas must escape unconsumed, even although the flames do not visibly smoke.

In concluding these remarks upon the effect of air-supply upon the illuminating power, the referees cannot but add that the question is one which is full of difficulties—hitherto baffling the ablest inquirers—and which they do not pretend to have wholly solved. The remarkable reduction in the illuminating power when gas is intermingled with even a small per centage of air is well known as a matter of fact, but no complete or satisfactory explanation of it has as yet been attained. That a reduction of the temperature of the flame must thereby be occasioned appears theoretically certain, and to some extent this is practically demonstrated by such experiments as the referees had the means of making. If a suitable pyrometer could be applied to gas-flames, this point might, doubtless, be determined with exactitude; but even this would not wholly exhaust the difficulties of the question treated of in this section; and all that the referees hope for and expect is, that the above remarks and experiments may smooth the path for future inquiries.

The Effect of the Temperature of Gas on its Illuminating Power.

Other questions, partly of a scientific and partly of a practical interest, connected with the illuminating power of gas, remain to be considered, before proceeding to the application of science to the construction of burners. The first of these is—What effect has the *temperature* of gas upon its illuminating power, and how does it affect the development of that illuminating power in burners? This question has been little investigated; but, in the main, it has been held that the warmer the gas supplied to the burner, the greater will be the amount of light obtained compared to the quantity of gas consumed. The most recent experiments on this subject are those made in the course of last year, in the laboratory of the University of Munich, which may be summarized as follows:—

The normal temperature of gas was taken to be 64½° Fahr.; and the illuminating power of the gas at this temperature, as the standard, was represented as 100. The burner was attached to a U-tube, which was immersed alternately in a freezing mixture and in a liquid at a high temperature.

I. *First, as to the Effect of Heating the Gas.*—When the U-tube was immersed in boiling water (temp. 212°), the illuminating power of the gas-flame rose from 100 to 164; and when melted paraffin was substituted for the water, and the temperature of the gas thus increased to 288°, the illuminating power rose to 118—showing an increase of 18 per cent. in the illuminating power of the gas in consequence of the rise of temperature.

Such results appeared to the referees inexplicable on any grounds yet known. From experiments made in connexion with various plans of sulphur purification, of the kind proposed by Mr. Bowditch and others, it is known that when gas is raised to a high temperature, a loss of illuminating power is incurred, chiefly from a deposit of the light-giving carbon elements of the gas.* But at any heat which does not thus alter the constitution of the gas, the only result of raising the temperature must be to increase its volume by expansion; and the effect of this expansion would simply be that, under the same pressure, *less* gas would pass through the burner in the same time when the gas was heated than when it was cool. Or rather, the gas being heated *after* it has passed through the meter, and the meter being made to pass (say) 5 feet an hour, then the heated gas, being enlarged in volume, would have to pass *more quickly* through the burner than if the gas were cool—*i. e.*, of the same temperature as it had when passing through the meter. Accordingly, as seemed to the referees, the only result to be expected from heating the gas would be to make it pass through the burner with greater velocity—in other words, under more pressure.

The question is one of considerable importance as regards the construction of burners, and two opposite views have been held on the subject, the Leslie burner having been devised on the theory that the gas should be heated as much as possible before being ignited; while Mr. Sugg and others, more recently, adopt the opposite opinion, and make their burners, in whole or in part, of non-metallic substances, in order (*inter alia*) that the gas may be heated as little as possible. In order to test the accuracy of the results obtained at Munich, and, generally, to ascertain correctly what effect (if any) temperature has upon the illuminating power of gas, the referees made the following series of experiments (the temperature of the room being about 65°):—

A 12-feet coil of half-inch metal pipe was placed in a water-bath; a metal pipe 18 inches long led from the top of the coil to the burner; and midway between the coil and the burner a thermometer was inserted in the pipe, in such a manner that the gas passed over the bulb. The water was then raised to the boiling-point (212° Fahr.), but the thermometer only rose one or two degrees and remained stationary. Oil was then used instead of water, and the coil was lengthened from 12 to 56 feet; nevertheless, when the oil was raised to its boiling-point (about 400° Fahr.), the thermometer in the gas only rose to about 79° Fahr. Inferring (as will appear, too hastily) from this that the gas, in passing through the coil, failed to absorb the heat from the surrounding oil, large shot were introduced into the coil of pipe, in order to conduct the heat inwards, and bring the gas at all points in contact with heated metal. Even then the thermometer hardly showed any further rise of temperature; but it was incidentally observed that the quicker the gas was sent through the pipe, the greater was the rise of the thermometer, although, of course, the gas was then for a shorter time in contact with the heated metal.

This fact at once showed that we had been working in the wrong direction, and that the stationary position of the thermometer was not so much owing to a difficulty in heating the gas in the coil, as to the rapidity with which the gas lost the heat so acquired, after leaving the coil. Accordingly, in the subsequent experiments, we surrounded the pipe leading from the coil with a jacket filled with boiling oil, and extending to within 2 inches of the point of ignition, the thermometer being again placed between the coil and the burner. The effect of this change in the apparatus was striking, the thermometer at once rising to 296° Fahr.—*i.e.*, to the highest temperature attained in the experiments made at Munich, and which, according to these experiments, produced an increase of illuminating power to the extent of 18 per cent.

Having thus obtained as high a degree of heat as could possibly be of use in such experiments, we made a bye-pass from the meter to the burner, through which the cool or unheated gas might be supplied to the burner; and the apparatus was so constructed that the burner could be supplied instantaneously with cool and with heated gas alternately, so that any change of illuminating power, produced by a high or low temperature of the gas, could be readily noticed. But *the heated and the cool gas gave exactly the same amount of illuminating power.*

It has been said, by a practical experimentalist of high standing, that to heat gas is equivalent to diluting it. But this is obviously a mistake; for, although the gas expands in volume by heat, no foreign body is mingled with it—it remains as pure as before. Hence, as appeared to the referees at the outset, if gas be burnt at a fixed rate per hour, the only effect to be expected from heating it is, that it must pass through the burner at an increased velocity—in other words, under greater pressure—and that any difference in the illuminating power of cool and of heated gas must be owing to the difference of pressure at which it is burnt.

The only intelligible motive that there can be for heating gas when supplied to the burner is, that this preliminary heating may enable the gas-flame to acquire a higher temperature, and consequently burn with greater brilliance. But such a result cannot reasonably be expected; for the heat which gas acquires when ignited is immensely greater than any which, in ordinary use, can be imparted to the gas as supplied to the burner. The heat of the flame of a Bunsen burner is said to be about 1800° C. (3272° Fahr.), and the heat of an ordinary gas-flame, as we have found, is still higher; so that the difference between the ordinary temperature, and the highest at which it is practicable to supply gas to a burner, is quite insufficient to make any appreciable difference in the temperature of the gas-flame.

* It is difficult to determine the temperature *above* the flame, and little reliance is to be placed upon the figures given in this column; but it was not necessary to attain exactitude in this matter.

* The temperature at which this change in the constitution of gas commences has not yet been accurately ascertained; but the referees are at present engaged in experiments on a large scale connected with the purification of gas from sulphur which, *inter alia*, will determine this point.

Indeed, as a practical question, *the only means of affecting the temperature of gas at the point of ignition is by the shape and material of the burner itself.* In the preceding experiments, it has been strikingly shown how rapidly gas *loses* its heat; and, as might thence be expected, gas acquires heat with equal rapidity. Now, as the temperature of a metal burner, when the gas is lighted, is about 500° or 600° Fahr. (more than *twice* as great as that obtained, either in our experiments or in those at Munich, by heating the gas before entering the burner), and as the gas nearly acquires that high temperature in passing through the heated burner, it is obvious that any lesser degree of heat imparted to the gas before entering the burner can be of no use at all; it can have no effect whatever in affecting the conditions under which the gas is burnt, either as regards heat or pressure, and therefore can have no influence upon the illuminating power.

As a practical deduction from the preceding experiments and reasoning, it appears that the advantage at present supposed to be derived from making burners of non-metallic substances (steatite, porcelain, &c.), in order to keep the gas at as low a temperature as possible at the point of ignition, is wholly imaginary. For although, *theoretically*, there is an advantage in keeping the gas comparatively cool, in order to lessen the *pressure* at which it issues from the burner (an object which can be more simply and perfectly attained by the construction of the burner itself), it is not less true that, theoretically, it is advantageous to make the gas as hot as possible at the point of ignition, in order to get a higher temperature in the gas-flame. But, we repeat, the above experiments demonstrate that neither of these opposite influences is of sufficient power to affect the ordinary conditions of gas combustion, and consequently the illuminating power. The only advantage, therefore (and it is a considerable one) of using non-metallic substances in the making of burners arises from their superior endurance, as they are not liable to oxidize like metal burners.

II. *Secondly, as to the Effects of Cold upon the Illuminating Power of Gas.*—In the experiments made at Munich, when the U-tube was immersed in snow, so as to bring the temperature of the gas down to 32°, the illuminating power is said to have fallen from 100 down to a point varying from 75 to 86; in other words, the light was reduced on the average to the extent of 20 per cent. And when the temperature of the gas was still further lowered, by using a mixture of salt and snow (temp. 4° below zero), the illuminating power was reduced by nearly one-third, ranging from 33 to 40, as against its full illuminating power of 100.

The latter temperature (4° Fahr.) is one to which, in this country, at least, gas as supplied to the public is never subjected; but as regards gas at the freezing-point (32° Fahr.) and a little below it, our experiments showed that this reduction of temperature made no difference in the illuminating power. By means of the bye-pass above mentioned, gas at the freezing-point, and at a temperature of 296° Fahr., was supplied alternately to the burner without making any difference in the readings of the photometer; so that the mere *cooling* of the gas (like the heating of it) has no effect whatever upon its illuminating power.

At the same time it must be said that when gas is subjected to a freezing temperature for some time, a considerable decrease of its illuminating power will certainly occur; for in such a case a change will be produced in the constitution of the gas. Just as a very high heat alters the composition of gas, greatly diminishing its illuminating power, so will extreme cold from a kindred cause produce a similar result. In the former case, there is a disintegrating chemical effect produced by excessive heat, occasioning, *inter alia*, a deposit of carbon; in the latter there is the effect of freezing, by which the water contained in gas, in the form of aqueous vapour, is separated from the gas in the form of ice, and a portion of the illuminating hydrocarbons are condensed along with it.

It is also to be observed that the effect of an extremely low temperature of the *atmosphere* will doubtless *tend* to diminish the illuminating power of a gas-flame, by tending to cool it; nevertheless the temperature of a gas-flame is so high that we doubt whether any change in the temperature of the air, either upwards or downwards, is sufficient to appreciably affect the illuminating power. Neither in our experiments nor in those made at Munich was this point determined; but we think it cannot be doubted that the double cooling influence to which gas is subjected during a continuance of frosty weather—namely, alike from the freezing of the aqueous vapour and a portion of the hydrocarbons with which it is associated, and also from the coldness of the air which feeds the flame—a very considerable loss of illuminating power may be confidently expected; and it may be observed, as a matter of fact, that in street-lamps (where the gas is fully exposed to the effects of temperature) there certainly is a marked diminution in the illuminating power during a severe frost. Our experiments, however, were specially directed to determine whether a mere cooling of the gas (apart from the alteration of its constitution by the freezing of its aqueous vapour) produced any loss of light-giving power; and we found that it did not.

The result of these experiments made by the referees entirely conflicts with that obtained in the laboratory at Munich, but, as appears to them, it is quite in harmony with the general principles which regulate gas combustion. And hence they consider that as regards the influence alike of heat and of cold upon the illuminating power of gas, it may be confidently stated that no effect whatever is produced, unless the heat or the cold is applied to such a degree as to alter the constitution of the gas. And, as a matter of fact, they found that no such change was produced between 32° and 300° Fahr.,—in other words, within any range of temperature which needs be taken into account.

The Effects of Distance from the Gas-Works upon the Illuminating Power.

On this point, as indeed on almost every other connected with gas, a diversity of opinion has hitherto prevailed. The general opinion is, that gas loses a portion of its light-giving power in proportion to the distance which it has to travel. And in the London Gas Acts of 1868-69, the companies successfully insisted upon having the testing-stations placed at not more than 1000 yards from the works.

The recent opening of the new works of the Chartered Company, at Beckton, has enabled the referees to make experiments of a very important kind upon this question; for the distance from the place of manufacture at Beckton to the point in the City where the supply begins, is nearly nine miles. A series of experiments was made at Beckton, and also upon the same gas when it arrived at the Brick Lane station of the Chartered Company; and the result of those experiments proved that the illuminating power of the gas did not appreciably suffer from the great distance which it has to travel.

The gas thus tested gives on the average a light equal to that of 17 candles, so that it is a somewhat richer gas than that supplied to London generally; and since no material loss of illuminating power takes place in it, it may be safely maintained that the ordinary 14 or 15 candle gas can travel a similar distance without damage.

It is to be observed that the gas from the Beckton works is supplied in unusually large quantity, and in a pipe 4 feet in diameter—circumstances which materially tend to counteract any evil effects from the distance which the gas has to travel; in the first place, because the great quantity tends to maintain the conducting-pipe at a suitable temperature, thereby lessening the tendency towards undue condensation; and secondly, by lessening the amount of friction to which the gas is subjected. During the experiments above described, the quantity of gas sent through the 4-feet main was only about 100,000 feet an hour; but as the Beckton works come fully into play (as will probably be the case next winter), the supply will rise to five times that amount, and the friction will then be considerably increased. Nevertheless, the referees have reason to expect that the result will remain the same—namely, that the gas will traverse the whole distance of nine miles without any appreciable loss of illuminating power. But this point will be determined by them during the ensuing winter.

In considering this satisfactory result of the novel and somewhat perilous enterprise of the Chartered Company, in placing their works so far from town, the referees (pending further experiments) are inclined to account for it mainly by the slow and gradual withdrawal of aqueous vapour from the gas in the course of its long journey. This condensation is very different in character from the sudden withdrawal of aqueous vapour produced by the application of great cold, for it takes place very gradually, so that the water is deposited without any appreciable portion of the hydrocarbons being condensed along with it. In order to ascertain the effect of withdrawing the aqueous vapour from gas, we made several experiments by passing gas through porous chloride of calcium—the result showing that dry gas has a superiority in illuminating power over ordinary gas to the extent of from 6 to 8 per cent.; but, of course, the gas loses proportionately in volume. If the gas which is manufactured and measured at Beckton were passed through a second meter at the point where the supply begins in the City, the extent to which a withdrawal of the aqueous vapour takes place by condensation could be readily determined; but the question can be determined in another way—namely, by ascertaining the difference in the amount of aqueous vapour in the gas as issued from Beckton, and as it arrives in town after its nine miles journey.

The above-mentioned testings of the gas supplied from Beckton are the first of a series of experiments by which the referees will determine what effect upon the illuminating power is produced by the distance which gas has to travel from the several gas-works to the various points of supply or distribution to the public. As regards common gas, at least, the referees think it probable that the diminution in the amount of aqueous vapour will be found to fully compensate the adverse influences of distance to which so much importance has hitherto been attached. Indeed, it seems probable that, in some cases, gas may actually acquire a slightly higher illuminating power (but with diminished volume) at a distance from the works than it had on leaving them. The whole question is one of great importance to the public, as the result of the experiments will satisfactorily determine whether or not the existing legislation as regards the position of the official testing-stations (namely, at 1000 yards from the gas-works) is an adequate security for the interests of the public.

The Transparency of Gas-Flames to Light.

If a printed paper be held behind the flame of a bat's-wing or fishtail burner, consuming common gas, the print may be read without difficulty. But a difference is plainly observable as regards the several parts of the flame; for, while vision is not perceptibly diminished by the blue portion of the flame, the print becomes manifestly less distinct when viewed through the upper or white part. And when cannel gas is used, the obstruction to vision produced by this white portion of the flame becomes still greater. The white part of a gas-flame unquestionably impairs vision of any object held behind it; and the richer the gas and the brighter the flame the greater is the obstruction which it presents to vision.

But although a gas-flame tends to obstruct the view of any object placed behind it, it does not necessarily follow that the flame impedes the transmission of light. It unquestionably obstructs sight, but does it obstruct light? If a stronger light is interposed between the eye and a weaker light, the weaker light is hidden; but it does not follow that its light is not transmitted in its full power to the eye. For example, when a printed paper is held behind a gas-flame, it is clearly seen through the blue part of the flame, because the reflected light from the paper (illuminated by the *whole* of the gas-flame) is greater than the light of the blue portion of the flame; but the paper becomes indistinct when viewed through the white portion of the flame, which emits a greater light than the reflected light from the paper. And when the paper is placed further behind the flame, in which position it reflects a smaller portion of the light than before, the paper becomes invisible to the eye, wholly hidden by the superior brightness of the interposed gas-flame.

A superior light always tends to render invisible an inferior light *of the same kind* placed behind it. On the other hand, a flame of equal intensity, but of a different quality or colour, makes itself distinctly visible through another, sometimes in its actual shape, but under all circumstances by the different tint or appearance which it imparts to the flame in front of it.

If two bat's-wing burners giving an equal light are placed behind one another, only one light will be visible to the eye, except in so far as the white part of the more distant flame may be seen through the blue part of the nearer flame. But if the two flames were of such a shape, and so placed that when viewed from the point of vision the white and blue portions of the one in front corresponded exactly with the white and blue portions of the one behind, then the two flames would be visible to the eye as *one*. On the other hand, if behind the burner in front there be placed one which gives a smaller but intenser flame, the form of the latter will be distinctly visible. For example, if immediately behind a bat's-wing consuming common gas there be placed a jet burner consuming cannel gas, the tall and narrow flame of the latter will be distinctly visible through that of the bat's-wing; and although its light appears diminished, this may be, and in the main certainly is, simply owing to the fact that, instead of being viewed (as when separately) against a background of comparative darkness, it appears in the middle of another flame. In short, if two gas-flames of identical shape, colour, and intensity are viewed behind one another, there will appear to be but one flame; but the question here to be determined is, although the two flames appear to the eye as one, do they or do they not give a double amount of light? Does the nearer flame in any degree obstruct the transmission of light from the other flame placed behind it? It obstructs vision—it obstructs sight, as regards any object beyond—but does it obstruct light?

If a gas-flame impedes the transmission of light from other gas-flames placed behind it, then there is, *pro tanto*, a defect in the Argand burner; for the light from one portion of the circular flame of the Argand has always to pass through the other portion. The question, moreover, is of some importance as to the arrangement of gaslights of all kinds, especially with respect to the grouping of Argands in a cluster of three, placed closed together, as is occasionally practised. If a gas-flame offers no obstruction to the light of other gas-flames or to a part of itself, then it matters not how the burners are placed or arranged; but if it does impede the transmission of light, then burners should not be arranged in such a manner that the light from one of them has to pass through that of the others, or even through a part of itself, as happens when a bat's-wing or fishtail burner is placed edgeways to the point of sight.

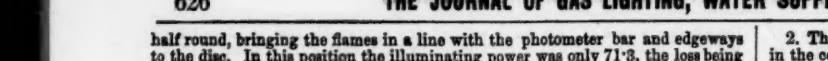
To determine this point—namely, the transparency of gas-flames to the light of other such flames—the following experiments were made in the laboratory of the referees:—

Three flat-flame burners (Sugg's No. 7 bat's-wings) were fixed 2 inches apart on a stand, consisting of a piece of tubing, in such a manner as to allow the positions of the flames to be changed without altering the consumption of gas, and with the central burner always remaining at the same distance from the photometer disc.

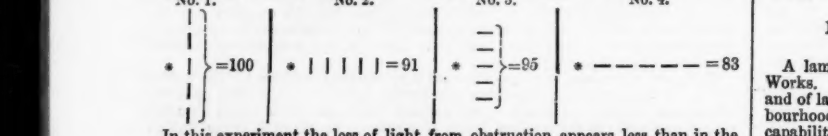
The illuminating power was first determined by placing the stand at a right angle to the point of view (or to the photometer bar), and with the flat side of each name exposed to the photometer disc, so as to allow the light from each burner to pass to the disc without any obstruction. The number thus obtained was taken as 100. The stand remaining as before, the burners were turned half round, so as to present the edge of the flames to the photometer. The illuminating power was again determined, and found to be only 85·5, showing a loss of 14·5 per cent. The stand was now placed in a line with the photometer bar, the flat side of the flames being exposed to the disc. In this position the illuminating power was 90·6, showing a loss of 9·4 per cent. The burners were then turned

half round, bringing the flames in a line with the photometer bar and edgeways to the disc. In this position the illuminating power was only 71·3, the loss being 28·7 per cent.

The following rough diagram will perhaps show more clearly than a verbal description the effect of the several arrangements of the gas-flames (marked —) upon the amount of light received from them on the photometeric disc, marked *:—



A similar set of experiments were made at Mr. Sugg's works with five fishtail burners (Sugg's No. 6) placed 2½ inches apart, the consumption of each burner being regulated, as in the previous experiment, to a uniform quantity by means of a separate governor. The results are shown in the following diagram :—



In this experiment the loss of light from obstruction appears less than in the former one, instead of greater, as it ought to have been when more burners were used. But, owing to the greater length of the stand upon which the burners were fixed (10 inches instead of 4), the light from the outer burners in the second experiment, when placed in a line at right angles to the photometer-bar, fall only indirectly on the disc; so that the illuminating power in position No. 1 ought to be reckoned higher than the actual reading of the photometer as given in the diagram. And in position No. 3 the illuminating power ought to be reckoned as lower, in consequence of the outer burners giving their light not really from the edge of the flames, but partly from their sides. Accordingly, although fewer burners were used in the first experiment than in the second, the photometric results obtained from the former may be regarded as more correct than those given by the latter.

From both of these experiments, however, it appears conclusively that gas-flames are not perfectly transparent, and considerably obstruct the light of other such flames placed behind them. Hence it is probable that the less perfect results obtained from Sugg's larger Argands compared with his smaller ones may be due to a greater loss of light by obstruction in the former than in the latter. Also, as above shown, the loss of light by such obstruction was greatest when the flames were placed edgeways to the photometer, in which position the depth of flame through which the posterior light had to pass was greatest.

Another apparatus of a similar kind was fitted with seven bat's-wings, 1½ inches apart; but in this case the burners proved to be imperfectly arranged, and gave varying results—owing apparently to the check on the air supply caused by the shape of the box and the proximity of the flames to one another. We note this case, as it is indispensable in such experiments that the burners be so arranged as never to allow the position of the flames to alter the conditions of combustion.

Conclusion of First Report.

The subject here dealt with by the gas referees naturally divides itself into two parts, namely—(1) the ascertainment of the principles which regulate the development of light from gas; and (2) the application of those principles to the construction of burners, and a demonstration by experiments of how far the various kinds of burners at present in use comply with those principles. As the varied series of experiments in connexion with the construction of burners are not yet completed, the referees think it best to deal with the latter part of this subject in a second report, which is now in preparation.

Besides the effect of the distance which gas has to travel upon its illuminating power, and also the experiments upon the transparency of gas-flames, the chief questions determined in this first report may be summarized as follows :—

1. It has been shown, by conclusive experiments—in opposition to the prevalent doctrine (embodied and exaggerated in the recent "Farmer theorem")—that gas may be used in any quantity with equal results as regards the development of its light; the great and startling differences so frequently observable in the illuminating power of the same gas when consumed in different quantities being wholly due to the burners, each burner doing most justice to the gas at a certain rate of consumption, and giving bad results when the consumption is either greater or less than that rate.

2. In regard to the effect of the temperature of the gas as supplied to the burner upon the illuminating power, it has been shown that the two conflicting doctrines at present maintained are both erroneous; and that, whether the gas be supplied heated or cool—*i. e.*, at the ordinary temperature—to the burner, makes no difference in the illuminating power.

3. The most important questions of all are—First, and practically, what are the best means of developing the illuminating power of gas? Secondly, as a matter of science, what explanation can be given of the influences which increase or diminish the luminosity of gas-flames? The first of these questions is treated of fully, under separate headings, in this report, and the principles arrived at will be applied to the construction of burners in the sequel. To the second question, no complete answer, substantiated by experiments, can as yet be given; the experiments of the referees throw a sure light only on a part of this question, and their further remarks are offered only suggeatively. Their investigations, however, appear to indicate that the only opinion hitherto offered in connexion with this subject—namely, that the illuminating power depends upon the length of time that the carbon-atoms are kept in a state of incandescence, and consequently that the more slowly the gas is consumed the higher will be its illuminating power—is imperfect as an explanation, and partly erroneous. They also show that an important, if not the chief, cause of imperfect illuminating power is the comparatively low temperature of the flame, in consequence of which the carbon-atoms do not vibrate so rapidly as to produce the full amount of light which they are capable of emitting at a higher temperature.

4. In connexion with this matter, it has also been shown how adverse to the illuminating power is an excessive draught, or over-supply of air, to gas-flames; for (apart from some other effects not yet adequately ascertained) such draughts not only throw too much air upon the surface of the flame, but may cause the air to intermingle with the gas, thereby introducing into the flame an incombustible body, which lowers the temperature of the burning gas by absorbing a portion of its heat.

5. The evil effects of "pressure" have been shown to be due to the same cause, the tendency of pressure being to increase the draught upon the flame. And it has been shown that gas gives its maximum of illuminating power when it is consumed—*i. e.*, issues from the burner—under little or no pressure; in which case the gas flows upwards, like the vapour of natural flames, simply by the ascending power due to its lightness relative to the surrounding atmosphere.

As points of detail it has been shown—

1. The gas should issue from the burner in such a manner that all parts of the flame are supplied equally, in order that no part of the flame shall smoke before the others. Also, it should issue with a smooth and even flow, without any swirl being imparted to it in the burner or from the construction of the tube between the tap and the burner, any unevenness of the flow causing the flame to "roar," and also, apparently, to produce a commingling of air with the gas, diminishing the illuminating power.

2. The poorer the gas, the less does its flame bear contact with the air. Indeed in the combustion of common gas in burners, the chief difficulty is to *keep down* the air supply, of which "pressure" is one of the most important elements.

3. Gas-flames always give their highest amount of light when just upon the point of smoking.

4. Even when burning at the rates best suited to them, some burners give much more light in proportion to the quantity of gas consumed than others; the difference between good and bad burners being so great that the best give 70 and even 80 per cent. more light than many of the burners in common use. As a question of practical consumption of gas, it is true, the loss of the public from bad burners is never so great as these figures show, but certainly it may be taken at from 25 to 40 per cent. Hence it is of great importance to the public, alike as regards economy and sanitary conditions, that the multitude of bad burners at present in use should be discarded, and that manufacturers should understand the proper principles for the construction of burners—a subject which will be fully treated of in the second part of this report. T. Foster, Secretary.

MELANCHOLY ACCIDENT AT WILMSLOW GAS-WORKS.

Six Men Suffocated.

A lamentable accident occurred on Saturday, Aug. 5, at Wilmslow Gas-Works. The works belong to the Wilmslow and Alderley Edge Gas Company, and of late, in consequence of the rapid increase of the population in the neighbourhood, it has been found necessary to increase the producing and storing capabilities. One part of the plan was the construction of a large gasholder, and it was in the trench dug for the tank, that the accident occurred. The workmen had dug a circular trench about 22 feet deep and 7 feet wide to receive the brick wall forming the sides of the tank, and at one side of the excavation an immense quantity of marl, to be used for puddling, was piled up, nearly 700 tons of clay puddling requiring to be used in the work. The direction of the proceedings was entrusted to the company's manager and engineer, Mr. Richards. At the side of the trench on which the marl was piled, the cutting was made to the depth of 23 feet 6 inches, in order to receive the outlet syphon. The workmen, under the instructions of Mr. Richards, seem to have been making a lateral excavation 6 feet 9 inches, by 2 feet 9 inches, in which to place a syphon, when the accident occurred. The soil from the surface to the bottom of the trench is composed of very fine sand, and as the work went on the sides were secured vertically and laterally by timber supports. Unfortunately, however, these do not seem to have been of a strength sufficient to resist the superincumbent pressure, and the consequence was that on the men cutting away the soil under the side of the trench, a large portion of the sand gave way and buried them. The names of those killed were—Frederick Richards, 36 years of age, married, who has left a widow and three children; George Worth, 23, unmarried; Noah Worth, 31, married; John Pearson, 27, unmarried; Stephen Duffy, 35, married, who has left a widow and four children; John Mottram, 65, married. Mottram was a slater, and merely went down into the pit as a spectator. He had been there only a few minutes when the accident happened. A man named Green had a very narrow escape. He was standing by the edge of the excavation when the slip occurred, and was buried up to the shoulders in sand. The only other workman on the spot who was saved was Oswald Hamilton. Mr. Charles Broadhurst, contractor for the brickwork, escaped almost by a miracle. He states that shortly before the accident occurred he said to Mr. Richards that he did not like the plan of driving irons into the side walls for the purpose of making the excavation for the syphon, and suggested that an auger might be used. Mr. Richards stepped upon the ladder to descend to the bottom of the pit in order to make an examination, and nearly missed his footing in consequence of one of the spokes of the ladder breaking. Mr. Broadhurst went to the adjoining purifying-house to get another stave, and while there heard the crash caused by the breaking of the timber. Mrs. Richards, with one of her children, was standing so near the excavation when the accident happened that her parasol fell into the cavity. Hearing the noise, Mr. Broadhurst immediately rushed out, and, with Mr. Benjamin Heywood, of Alderley, took steps for clearing away the sand under which the unfortunate men were buried. This, however, was a work of very great danger and difficulty, owing to the loose state of the soil, the sides having to be supported by planks as the digging went on. A large crowd assembled round the gas-works, and upwards of 20 men set to work with great energy, under the orders of Mr. Heywood and Mr. Broadhurst, to recover the bodies, for even then there was not the slightest hope of any of the men having escaped almost instant death. The first body got out was that of George Worth, which was recovered about four o'clock on Sunday morning, and in about an hour afterwards the body of his brother, Noah Worth, was found. The excavation then became still more difficult and dangerous, and the bodies of Mr. Richards and Mottram were not reached till eight o'clock on Sunday evening. Pearson and Duffy were got out on Monday morning about four o'clock. All the bodies were found in a standing posture. Pearson was to have been married next week. The bodies of the men, on being dug out, were removed to their homes to await the inquest.

The inquest was held on Tuesday, Aug. 8, at the Ring of Bells Inn, Wilmslow, before Mr. W. J. R. Dunstan, the district coroner.

Mr. B. H. Green, solicitor, Wilmslow, attended on behalf of the relatives of four of the deceased; and Mr. W. L. Welsh appeared for the Wilmslow and Alderley Edge Gaslight Company, Limited; and Mr. T. Chadwick, chairman of that company, was also present.

Charles Broadhurst, bricklayer, said he had contracted with the gas company for the brickwork in connexion with the tank of the new gasholder. On Saturday, about noon, after the workmen had gone to dinner, he went down into the trench with Mr. Richards to look at the place where it was proposed to place a syphon-box. The diggers had there reached quicksand. Except at that spot (where it was 23 feet 6 inches deep) the trench was 21 feet 6 inches deep. The sides of the excavation, consisting of sand, were all timbered, except that 2 feet of difference. On the surface at one side were 6000 or 7000 tons of wet clay for puddling the sides. Mr. Richards stuck his spade in the quicksand, and asked what they should do about it, when witness remarked that they must be very cautious, as it would be impossible to get down the necessary distance of 3 feet 1 inch into the quicksand. Witness took a bore, forced it into the quicksand, and took some out with a spade; but the hole was immediately filled up again by a current of water and sand. By turning an arch over the place, Mr. Richards proposed to reduce the depth of the proposed hole in the quicksand to 1 foot 2 inches instead of 3 feet 1 inch; and said it would be the best to put in the puddle just as they took out each spadeful of sand. In experimenting with this view they drove two iron bars into the bank, but at the second stroke a quantity of sand fell, whereupon witness suggested the use of an auger as better than the concussion of driving, but Mr. Richards did not take notice, preferring to go on with the driving. After putting the fourth bar into the cavity, a shunt of sand came down about nine or ten feet, but this was immediately afterwards boarded and made secure. This alarmed the witness, but the other men said that larger slips had previously taken place. About six o'clock witness went up to tea, and Richards also climbed up to the bank. Soon after the return of witness, between seven and eight o'clock, he went down the trench, passing Mr. Richards, who was with his wife on the bank. The deceased Mottram followed down the ladder, and then Mr. Richards also came down, and found one of the ladder staves broken or cracked. This was caused by a piece of wood which had fallen from the top. Mr. Richards told witness to go up at once for a new stave, which he did, leaving down the six men who were now dead and another named Green. Whilst away getting a fresh stave, he heard a rumbling noise, and on running to the spot

found that a body of sand had fallen in and filled up about ten or twelve yards of the trench. The deceased were not to be seen, but he saw Green buried to above the waist, and struggling to get out. After Green had been extricated several men commenced to dig for the others; but there was some delay in this, as they were at first afraid to go upon the sand lest more should fall. When witness left the place about four o'clock on Sunday morning, none of the bodies of the deceased had been got out. He thought that Mr. Richards, upon whom the responsibility of the work rested, had been engineer to the company about seven years. Some of the clay, which was piled about nine feet high in some places, lay close to the edge of the trench, but none of it fell in, nor did it appear to have undergone any subsidence. The "waling boards" would have been quite safe had they been completely sheathed, which they were not.

John Green, labourer, said he was in the trench on Saturday evening along with the six deceased, who were working overtime. He was watching three of the workmen undermining for the syphon, when suddenly a fall of sand took place and buried all who were down at the time. When got out in the course of Sunday and Monday morning, most of the bodies were still in a standing position, the sand having fallen equally all round them. Witness had no apprehensions concerning his safety when down in the trench; nor did he know of any of the men having left the work or refused to work because of any suspicion of danger. The fall of sand was caused by the undermining, but it might have been accelerated by the previous concussion through the driving in of the iron bars horizontally.

Oswald Hamilton, another labourer, gave corroborative evidence, and stated that he had just ascended and stepped off the top of the ladder when the fatal sandslip took place.

John Lee, foreman at the gas-works, was called at the request of the jury. He said he had never heard any of the men complain of Mr. Richards being in any way incompetent, or of the work being dangerous. He considered, so far as his own knowledge went, that every necessary precaution for safety had been taken. It would have been better, no doubt, if the sides had been closely boarded round, instead of the upright poles being set occasionally small distances apart. It would doubtless have secured perfect safety if the circumference of the trench for the tank had been extended sufficiently to leave room for the syphon, without undermining a hole for the purpose. Although in the service of the gas company as engineer and manager, Mr. Richards was not expected to devote his time and services exclusively to their work.

Mr. WELSH said, in reply to a remark by the coroner, that the deceased Mr. Richards was not interested in limiting the expense of the work. On the contrary, he was paid for it by commission, and no limit was prescribed by the company as to its cost.

The CORONER, in addressing the jury, said there was no evidence to show that the lamentable mishap in question was due to any gross or culpable negligence. Even were it otherwise, the only person who could possibly be censured was Mr. Richards, who unfortunately was beyond the reach of any remarks of theirs; but there really did not seem to be the slightest reason to suspect more than an error of judgment, if even that, on behalf of that unfortunate gentleman.

After a brief consultation, the jury found a verdict of accidental death. They were of opinion that the fall occurred through the undermining of the sand and through the outer side of the trench not having been sufficiently boarded.

The CORONER said it appeared that when Green was extricated from the sand he set to work digging resolutely to save the others, and so continued until the last of the bodies was got out on Monday morning. He (the coroner) had no power to reward him, but it was right to express publicly a sense of his creditable conduct, in order that it might be noticed by his employers.

The jury expressed their concurrence in the coroner's remarks.

NOTES ON THE PRACTICAL PHOTOMETRY OF COAL GAS.

By Dr. WALLACE,

Gas Examiner for the City of Glasgow.

[From the *Chemical News.*]

The following arrangement of the different parts of the photometric apparatus has been found convenient, and has been so highly approved of by those who have seen it that it is thought worthy of a brief description. The meter is not placed at the end of the photometer-bar at which the gas is burned, but towards the candle end, and immediately below that part of the bar where the observations are usually made; and attached to the outlet is a three-way stop-cock, with lever handle, the side branch of which is connected by a few inches of pipe with the inlet, so that the gas may be passed through the meter, or direct to the burner, as may be desired, the gas being, in either case, kept constantly burning. At the candle end, and on a level with the photometer-bar, is placed a small shelf supporting the candle-balance; and this is arranged so that the candles have to be moved only a few inches into the receptacle at the end of the photometer. The gas is now passed through the meter until the hand comes to zero, and the stop-cock is turned so as to pass the gas direct to the jet. The clock, which is either attached to the meter or placed immediately beside it, is also adjusted, and the candles are nearly counterpoised. At the moment when the balance turns, the operator with one hand turns the stop-cock, and with the other sets the clock in motion. The candles are now placed in position, and by the end of the first half minute the operator is ready to take the first observation. The sight-box has in front of it stereoscopic lenses, so as to shorten the focus of the eyes, and make the images of the two sides of the disc more distinct, at the same time that they coalesce or overlap one another. By this means great accuracy of observation is attained, and the influence of the different colours of the two flames is entirely removed. Two circular screens of very light wood, 18 inches in diameter, strengthened by cross-bars, and having in the centre openings 4 inches square, are fixed on the photometer-bar, one on either side of the sight-box, and about 20 inches apart; and the sight-box is provided with two side flaps of thick vulcanized india-rubber, the object of these arrangements being to prevent the possibility of any light passing to the eyes of the operator but that reflected by the mirrors in the sight-box. At the end of the tenth minute the stop-cock of the meter is reversed, and, at the same moment, the candles are extinguished; after which the operator leisurely notes the consumption of gas and the loss of weight of the candles. The advantage obtained by this arrangement is, that the gas examiner does not require to move from his position opposite the meter during the whole experiment, while the meter is read off only when stationary. The stereoscopic sight-box is not an essential part of the apparatus, and requires great care in the adjustment of the lenses; but, when these are carefully fixed, the results obtained are highly satisfactory.

In the arrangement above described, the governor is placed immediately to the right hand of the meter (supposing the gas to be burned at the right side of the photometer), and the King's pressure-gauge at the left-hand side, so that both are readily observed or corrected. The pressure at which it has been found best to burn the Glasgow gas (28 to 30 candles) is from four to five tenths, and the standard cannel bat's-wing supplied by Sugg is employed at all the testing-stations. In order to prevent evaporation, the surface of the water in the meters, pressure-gauges, and governors is covered with a layer of about 1-16th of an inch of "intermediate" paraffin oil. This oil has a gravity of ·850 to ·860, and a firing-point of about 250° Fahr., and does not affect the illuminating power of the gas, nor does it thicken by exposure to cold.

In the estimation of the sulphur in coal gas it is usual to cut off the gas, by means of a pin acting on a lever, at 10 cubic feet; but it is more advantageous to adopt 13·7 cubic feet as the quantity, as in this case the number of grains and fractions of a grain of barium sulphate obtained represents the number of grains of sulphur in 100 cubic feet of the gas. The half of this quantity, or 6·85 cubic feet, may also be taken, but in this case the quantity of barium sulphate must be multiplied by two. The apparatus used in Glasgow is that of Dr. Letheby, with the addition of a second cylinder of about twice the capacity of the first.

The estimation of ammonia is made by means of a very simple apparatus. A tray of copper coated with paraffin, or, still better, one of porcelain, about 12 inches long by 4 wide, and 1 inch deep, has inverted in it a similar vessel 11½ inches long, 3½ inches wide, and nearly the same depth as the tray. At each end of the inverted vessel is a coupling, so that the gas to be used in the sulphur estimation can be passed through this apparatus before going to the burner. Into the tray is placed 100 measures of a test-liquid consisting of dilute sulphuric acid, of such strength that this quantity would be exactly neutralized by 13·7 grains of ammonia; and water is added, if necessary, to give a depth of about a quarter of an inch of liquid: 13·7 cubic feet of gas are now passed through the apparatus in the usual manner, after which the contents of the tray are transferred to a white porcelain basin, and the tray and inverted vessel washed by means of a washing-bottle, and the washings added. Some tincture of litmus is now added, and from a burette is dropped, with constant stirring, a solution of caustic potash, 100 divisions of which correspond exactly to 100 divisions of the dilute acid. When the blue colour of the litmus is restored, the number of divisions consumed is read off, and the difference between it and 100 divided by 10 gives the number of grains of ammonia in 100 cubic feet of gas. The absorption of the ammonia is so perfect, that not a trace can be detected by afterwards passing the gas through the ordinary bulbs filled with beads or broken glass.

AVERAGE COMPOSITION AND QUALITY OF THE METROPOLITAN WATERS, IN JULY, 1871.—The following are the returns of the Metropolitan Association of Medical Officers of Health:—

NAMES OF WATER COMPANIES.	Total Solid Matter per Gallon.	Oxygen required by Organic Matter, &c.	Nitrogen.		Hardness.	
			As Nitrates, &c.	As Ammonia.	Before Boiling.	After Boiling.
Thames Water Companies.	Grs.	Grs.	Grs.	Grs.	Degs.	Degs.
Grand Junction	18·33	0·107	0·120	0·002	13·8	3·6
West Middlesex	17·10	0·070	0·118	0·000	13·2	3·3
Southwark and Vauxhall	17·23	0·092	0·110	0·005	13·6	3·4
Chelsea	17·93	0·111	0·110	0·003	13·8	3·5
Lambeth	18·63	0·079	0·111	0·002	14·0	3·6
Other Companies.						
Kent	27·93	0·010	0·212	0·000	20·0	5·8
New River	17·40	0·023	0·120	0·001	14·0	3·3
East London	18·33	0·037	0·129	0·002	14·3	4·0

Note.—The amount of oxygen required to oxidize the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours; and in the case of the metropolitan waters the quantity of organic matter is about eight times the amount of oxygen required by it.

The water was found to be clear and nearly colourless in all cases but the following, when it was more or less turbid—namely, in that of the Grand Junction and the Chelsea Companies. The average quantity of water supplied daily to the metropolis during the preceding month was, according to the returns of the water companies to the Association of Medical Officers of Health, 111,190,422 gallons; and the number of houses supplied was 487,650. This is at the rate of 34·1 gallons per head of the population daily. H. LETHEBY, M.B.

BURSTING OF A WATER-MAIN AT LEICESTER.—Considerable alarm was occasioned in High Street, one of the principal thoroughfares of Leicester, on Friday, Aug. 4, by the bursting of one of the mains of the water-works. These mains are over 2 feet in diameter, and the loud report, accompanied by the sudden upheaval of the ground, followed by the issue of a thick column of water to the height of about 60 feet, naturally caused much consternation. The pavement for some distance around was torn up, the stones being hurled into the air, while so vast was the issue of water that soon the locality was completely flooded—cellars filled, and the streets in many places over a foot deep in water. Considerable damage was done to the house of Dr. Lankester, the water falling with great force on to the roof, which was broken in, as also several windows, and nearly every room deluged. As soon as possible the water was turned off, but the vast column of water continued to issue for over an hour, flooding not only the locality, but also the low-lying districts adjacent. Consequent on the repairs, Leicester was the following day without a water supply, and great inconvenience was experienced.

STEALING GAS AT MANCHESTER.—At the City Police Court, last week (before Mr. Headlam) *Thomas Banks*, shopkeeper, 40, Price Street, Every Street, Ancoats, was charged with having stolen a quantity of gas, the property of the Manchester Corporation. On Saturday evening, detective Clayton, accompanied by some other officers, proceeded to the house of the prisoner. They found that the end of a leaden pipe had been attached to one which had been stopped up. By means of this arrangement the defendant obtained a supply of gas to a burner in the window without the gas passing through the meter.—Mr. Headlam: What made you put the pipe there?—The Prisoner: Just for the sake of a little bit of extra light in the window on Saturday night. I did not know but that it went through the meter, or I should not have done it.—Mr. Headlam: I don't believe it. I shall fine you £5 for the offence, and 40s. for every day the illegal pipe has been used.

BERLIN WATER-WORKS COMPANY.—The ordinary half-yearly meeting of this company was held on Tuesday, Aug. 8, at the London Tavern, Mr. J. C. Sim in the chair. The report, which showed an amount of £35,876 16s. 10d. at the disposal of the shareholders, was adopted, and an interim dividend for the half year, at the rate of 10 per cent. per annum, was declared. A balance of £5376 16s. 10d. was carried to the next account.

GAS TESTING-HOUSE AT BECKTON.—At the meeting of the Metropolitan Board of Works on the 28th ult., the Works Committee reported that a gas testing-place had been fixed by the gas referees at Beckton, near Barking, at which the whole of the gas supplied by The Gaslight and Coke Company, both within and without the City, will eventually be tested; and recommended that, inasmuch as the Act of Parliament only allows one testing-place, a proposal should be made to the City Corporation that the gas examiner be nominated alternately by the corporation and the board, the first nomination being made by the corporation, and that the examiner so nominated be formally appointed by the corporation to test the gas supplied to the City of London, and by this board to test the gas supplied outside the City; the expense of the examiner being borne, one-half by the board and one-half by the corporation. The report was approved, and a formal proposal was directed to be made in writing to the corporation.

Register of New Patents.

2433.—JOHN HENRY JOHNSON, of 47, Lincoln's Inn Fields, in the co. of Middlesex, gentleman, for "*Improvements in pipe-joints or couplings, applicable also to couplings for rods and shafting.*" A communication. Patent dated Sept. 8, 1870.

This invention consists of a coupling in which tapering and vanishing screw-threads on the ends of tubes or pipes, and rods or shafting to be coupled together or combined with a socket having internal vanishing and tapering screw-threads corresponding to those on the said tubes or rods to be coupled, whereby a more perfect and secure junction is obtained than has been heretofore accomplished by screw couplings.

In carrying out this invention a tapering external screw is cut on the ends of the pipes or rods to be joined, but instead of cutting the thread of this screw to one uniform depth it is so cut that it shall gradually vanish until it disappears at the exterior of the tube. The socket instead of having a screw-thread cut through it has two screw-threads tapering one in one direction for receiving the end of one tube or rod, and the other in another direction for receiving the end of the other tube or rod, the tapers of each screw corresponding with that of the tube or rod which it has to receive, and the screw-thread vanishes to correspond with the vanishing thread of the tube or rod.

2434.—TREAT TIMOTHY PROSSER, of Chicago, Illinois, U.S.A., engineer, at present residing at 198, St. Vincent Street, Glasgow, in the co. of Lanark, N.B., for "*A new or improved tube-expander and tube-cutter combined.*" Provisional protection only obtained. Dated Sept. 8, 1870.

These improvements consist in making the part of the mandrel or spindle of the tool which enters the tube of a cylindrical form a little less in diameter than the inside of the smallest tube, within which it is required to act, and having two segmental parts of the spindle cut away on exactly opposite sides from near the point where a short cylindrical part is left to, say, 6 or 8 inches back, with two dovetail or inverted rebate edged grooves cut down the centre-web, thus left, and made deepest towards the point, but parallel in width along the edges and on the sole, sufficiently long for the centre part of the web left along the bottom of grooves to form or give the wedge or double inclined plane action to the expanding and abrasing rollers, pulleys, or wheels, and cutter of the tool. Three or more screw-holes or other recesses are formed at equal distances apart round the circumference of the cylindrical point of the spindle left in front of the slots for the insertion of various heights of case-hardened bearing studs, so as to make it fit and work steadily in the particular size of tube it is to operate on.

2437.—GEORGE HENRY ELLIS, of 20, High Holborn, in the co. of Middlesex, engineer, for "*Improvements in steam, gas, and air engines.*" Patent dated Sept. 9, 1870.

These improvements have for their objects to obtain a more direct and uniform movement than can be obtained by means of the crank arrangement now employed, and the same are applicable to the driving-shaft carrying the fly-wheel and rigger, as also to the slide-valve and pump-rods of steam, gas, and air-engines.

To carry out these improvements a drum or cam is employed, having a right and left hand worm or screw formed in or upon the same, or with a suitable diagonal channel or channels cut therein. This drum or cam is disposed in a suitable manner to receive the ends of the piston or other rods working in the worms or screws, or in the said channel or channels, and by the reciprocating action of the piston a continuous and direct rotatory movement is imparted to the said drum or cam. Wheels or pulleys may be used for diminishing friction in the channel of the drum or cam, and suitable roller or other guides are provided for the piston and other rods. It will be understood that in its application to the slide-valves and to pumping the drum or cam must be the actuating body.

2451.—ARCADI STOLIPINE, of St. Petersburg, in the empire of Russia, manufacturer, for "*An apparatus for lighting with legroine gas (petroleum spirits).*" Provisional protection only obtained. Dated Sept. 10, 1870.

These improvements relate to a lamp or apparatus for burning legroine gas or petroleum spirit. The burner consists of a small tube having at the top a slit, and to this tube is brazed a second tube, to the lower part of which is brazed another tube. In the centre of the tubing below the burner there is a copper or brass rod fixed at the bottom to the vessel containing the fluid, from which the gas is generated, and to the top of the rod is brazed a hollow perforated head, to which is fixed a wire gauze tube extending downwards, there being brazed to the top of the wire tube a short tube used as a gas collector or reservoir.

2460.—ALFRED TYLOR, of No. 2, Newgate Street, in the City of London, brass-founder, for "*Improvements in wet and dry closets, and in apparatus connected therewith.*" Patent dated Sept. 12, 1870.

The object of this invention is to combine the advantages of the wet and dry system of closets by the use of a moveable soil-pipe so that the cleanliness of the water system may be obtained while the excrementitious matter is preserved in a dry state and not deteriorated by contact with a mass of water.

Water is economized by an improved cistern arrangement, or by a self-closing spring valve attached to the water supply, or by a metallic diaphragm valve.

The apparatus consists of a closet pan, supported on a frame and placed over the upper end of a short moveable soil-pipe open at both ends, and larger than the opening in the pan, so suspended as to discharge the excrementitious matter and urine (valuable for manure) passing through this moveable soil-pipe into a detached or permanent receptacle below. The receptacle may be lined or partially filled with disinfecting material, and may have an overflow-pipe dipping into the drain as a precaution against accident. When the closet is in use by means of a handle or the weight of a sitter acting upon a lever connected with a moveable tubular soil-pipe, one end of the moveable soil-pipe is depressed so that the fœcal matter passes through it into the receptacle. When this arrangement is reversed, the same end of the soil-pipe is raised and at the same time actuated with the water supply to the pan, so that when the water enters the pan the lower end of the moveable soil-pipe is turned into the mouth of the drain-pipe outside the before-mentioned receptacle, so that the cleansing water from the closet-pan passes into the drain. A separation is thus made between the greater part of the water which would have diluted it and rendered it less valuable. A circular brush or scraper or vessel in the shape of a segment of a circle is fixed on an axle at the bottom of a box filled with sifted earth, cinders, or sand, with a portion of sulphate of iron, and which is situated at the back or side of the pan. This brush is also synchronously actuated, so that the soil and urine which has fallen into the receptacle is immediately covered by proper materials for absorbing or fixing the nitrogenized matter. The moveable tubular soil-pipe should be actuated by means of a door, seat, or cover in such a manner as to afford an open passage for soil passing through the closet-pan to the receptacle when the closet is in use, but if from any reason the receptacle is not in readiness, the soil-pipe may be fixed so that everything falling into the basin passes direct into the drain. One waste-preventing cistern is enabled to work several closets or discharge-pipes, the one entrance for the water to the cistern is closed by a ball-valve with ball-rod and ball. The exit valve or valves having a chain and a pull attached to another level placed under the ball-rod, and working on an axle into the cistern, so that the ball-valve cannot be kept open when either of the exit-valves are open. When the self-closing valve is to be fixed below, the valve is opened either by a lever, handle, or disc, and a good coiled, hardened, tempered, electro-covered steel spring, brightened after being tempered so as to offer a smooth surface before being electro-covered, is enclosed in a box fixed to or above the valve. A metallic flexible diaphragm valve may be used with or without a spring for drawing water from cisterns. When the valve is closed by a vertical screw spindle, one end of the above spring is fixed in the box and the other to a nut through which the screwed spindle of the valve works, so that the spring may have little or no vertical movement, and is so placed as to prevent water escaping to the spring from the valve by as complete separation as possible, which is effected either by providing a chamber between the valve and the spring box through which water leaking past the valve might escape below the spring, or by attaching a flexible metal or an india-rubber diaphragm washer to the screw spindle without a hole being made through the india-rubber, or where a hole is employed by taking care that the junction with the metallic or the india-rubber diaphragm is water-tight. The dry closet and cistern and valve apparatus for drawing water from cisterns can be used separately or in conjunction.

APPLICATIONS FOR LETTERS PATENT.

1845.—FREDERICK PHILIP PRESTON, JOHN THEODORE PRESTIGE, EDWIN JAMES PRESTON, and WILLIAM ALFRED PRESTIGE, trading under the firm of Josiah Stone and Co., of High Street, Deptford, in the co. of Kent, engineers, for "*Improvements in waste-water preventer taps, so that they shall act without the use of plug-cocks.*" July 14, 1871.

1847.—FELIX NAPOLEON TARGET, of 2, Westminster Chambers, in the city of Westminster, civil engineer, for "*Improvements in dry closets and commodes.*" July 14, 1871.

1857.—FREDERICK JOHN EVANS, of Clayponds, Brentford, in the co. of Middlesex, civil engineer, for "*Improvements in the purification of illuminating gas.*" July 15, 1871.

1859.—ALFRED GARDINER BROWN, of 63, Trinity Square, in the borough of Southwark, surgeon, for "*Improvements in means of disinfecting water-closets, urinals, as well as gutters and other conduits.*" July 17, 1871.

1876.—HENRY VAUGHAN, of 78, Monks Road, in the city of Lincoln, engine-fitter, for "*An improved self-acting escape-valve for drawing off the condensed fluids from steam-engines, pipes, and other vessels.*" July 18, 1871.

1896.—ARCHIBALD KENNEDY IRVINE, of Glasgow, in the co. of Lanark, N.B., for "*Improvements in apparatus for the safe combustion of inflammable gas, and applicable for mine-lamps for indicating danger, and for signalling.*" July 20, 1871.

1897.—FERRAR FENTON, of Dewsbury, in the co. of York, for "*Improvements in the purification and utilization of sewage and other refuse matters, whether in a liquid, semi-fluid, or solid state, part of which invention is also applicable to other useful purposes.*" July 20, 1871.

1919.—ROBERT WARNER, of Jewin Crescent, in the City of London, brass-founder, and JOHN BROOKE, of the same place, foreman engineer, for "*Improvements in pumps.*" July 21, 1871.

1937.—FREDERICK PHILIP PRESTON, JOHN THEODORE PRESTIGE, EDWIN JAMES PRESTON, and WILLIAM ALFRED PRESTIGE, trading under the firm of Josiah Stone and Co., of High Street, Deptford, in the co. of Kent, engineers, for "*Improvements in waste-water preventer cisterns.*" July 22, 1871.

1940.—ISAAC BROWN, of Elur Croft Grange, Edinburgh, in the co. of Mid Lothian, N.B., for "*Improvements in the irrigation of land, the watering of streets and roadways, and in the apparatus to be used for such purposes.*" July 22, 1871.

1942.—JOHN LEWTAS, of Manchester, in the co. of Lancaster, for "*Certain improvements in the construction of lamps employed for illuminating purposes.*" (Complete specification.) July 24, 1871.

1955.—JAMES DARSIE MORRISON, of 27, Grange Road, Edinburgh, in the co. of Mid Lothian, N.B., surgeon dentist, for "*Improvements in purifying water or other solvents so as to qualify them to purify other bodies by simultaneous and continuous filtering, and simultaneous and continuous distilling apparatus.*" July 25, 1871.

2007.—ALBERT MARCIUS SILBER, of Wood Street, Cheapside, in the City of London, merchant, and FREDERICK WHITE, of Camberwell, in the co. of Surrey, watchmaker, for "*Improvements in apparatus for lighting and heating purposes.*" July 31, 1871.

2025.—DAVID HANCOCK and CHARLES PEARSE, both of High Wycombe, in the co. of Bucks, for "*Improvements in the production of lighting gas, and in apparatus therefor.*" Aug. 1, 1871.

2053.—EDME AUGUSTIN CHAMEROY, of 123, Boulevard de Strasbourg, Paris, for "*Improvements in apparatus for regulating the pressure in delivery-pipes of water, gas, steam, and other fluids.*" Aug. 2, 1871.

2047.—JAMES HOSKEN, of 58, Fenchurch Street, in the City of London, engineer, and FRANCIS GEORGE FLEURY, of 24, Merrick Square, Southwark, in the co. of Surrey, engineer, for "*Improvements in water-waste preventers, or automatic apparatus for regulating the flow of liquids from constant supply-pipes or vessels.*" Aug. 3, 1871.

2062.—ALEXANDER ANGUS CROLL, of Coleman Street, in the City of London, for "*Improvements in meters for measuring water or other fluids.*" Aug. 4, 1871.

2063.—GEORGE GOLDSMITH and JAMES DILKES, both of Leicester, in the co. of Leicester, for "*Improvements in apparatus for heating by gas.*" Aug. 4, 1871.

2076.—ANDREW BARCLAY, of Kilmarnock, in the co. of Ayr, N.B., for "*Improvements in coking coal and generating gas for heating and other purposes, and in the apparatus employed therefor.*" Aug. 5, 1871.

2109.—JAMES BECKETT and JOHN JAMES CAM, both of Worcester, in the co. of Worcester, engineers, for "*Improvements in treating sewage.*" Aug. 10, 1871.

2112.—THOMAS CHARLES PEARSON, of Openshaw, near Manchester, in the co. of Lancaster, for "*Improvements in self-cleansing high-pressure filters.*" Aug. 10, 1871.

GRANTS OF PROVISIONAL PROTECTION.

845.—ALEXANDER ANGUS CROLL, of Coleman Street, in the City of London, for "*Improvements in the treatment of ammoniacal liquor to obtain salts of ammonia.*" March 29, 1871.

1485.—SAMUEL WHITAKER, of Liverpool, in the co. of Lancaster, licensed victualler, for "*Improvements in taps or cocks.*" June 5, 1871.

1695.—MIGUEL PINDER, of Faro Algaroe, Portugal, but at present of Walworth, in the co. of Surrey, for "*Improvements in joints for pipes.*" June 29, 1871.

1713.—WILLIAM ROBERT LAKE, of the firm of Haseltine, Lake, and Co., Southampton Buildings, London, patent agents, for "*Improvements in mechanism for operating the valves of water-meters.*" A communication. July 1, 1871.

1741.—ALFRED SAVAGE DIXON, of Leeds, in the co. of York, brassfounder, for "*An improved water-gauge or other gauge-cock.*" July 4, 1871.

1745.—JESSE HILDRED, of Batley, in the co. of York, borough surveyor, for "*Improvements in apparatus for ventilating and trapping sewers, and for affording access thereto.*" July 4, 1871.

1749.—MATTHEW WILSON, of Hill's Place, Oxford Street, in the co. of Middlesex, wine merchant, for "*Improvements in sink-traps.*" July 5, 1871.

1797.—THOMAS WHITWELL, of the Thornaby Iron-Works, Stockton-upon-Tees, in the co. of Durham, for "*Improvements in valves.*" July 8, 1871.

1804.—WILLIAM HOLLINSHEAD, of Peckham, in the co of Surrey, for "*Improvements in the method of and apparatus for lighting railway carriages with gas.*" July 11, 1871.

1845.—FREDERICK PHILIP PRESTON, JOHN THEODORE PRESTIGE, EDWIN

JAMES PRESTON, and WILLIAM ALFRED PRESTIGE, trading under the firm of Josiah Stone and Co., of High Street, Deptford, in the co. of Kent, engineers, for "*Improvements in waste-water preventer taps, so that they shall act without the use of plug-cocks.*" July 14, 1871.

1847.—FELIX NAPOLEON TARGET, of 2, Westminster Chambers, in the city of Westminster, civil engineer, for "*Improvements in dry closets and commodes.*" July 14, 1871.

1857.—FREDERICK JOHN EVANS, of Claypends, Brentford, in the co. of Middlesex, civil engineer, for "*Improvements in the purification of illuminating gas.*" July 15, 1871.

1864.—WILLIAM EDWARD GEDGE, of 11, Wellington Street, Strand, in the co. of Middlesex, patent agent, for "*Improvements in the formation and joining of bricks for constructing pipes or tubes and other circular or curved brickwork.*" A communication. July 17, 1871.

1896.—ARCHIBALD KENNEDY IRVINE, of Glasgow, in the co. of Lanark, N.B., for "*Improvements in apparatus for the safe combustion of inflammable gas, and applicable for mine-lamps for indicating danger, and for signalling.*" July 20, 1871.

1919.—ROBERT WARNER, of Jewin Crescent, in the City of London, brass-founder, and JOHN BROOKE, of the same place, foreman engineer, for "*Improvements in pumps.*" July 21, 1871.

1940.—ISAAC BROWN, of Elm Croft Grange, Edinburgh, in the co. of Mid Lothian, N.B., for "*Improvements in the irrigation of land, the watering of streets and roadways, and in the apparatus to be used for such purposes.*" July 22, 1871.

1969.—EDWARD TAYLOR, of Rochdale, in the co. of Lancaster, for "*Improvements in the treatment of human excreta, and of blood and towns refuse for the manufacture of manure therefrom.*" July 27, 1871.

2025.—DAVID HANCOCK and CHARLES PEARSE, both of High Wycombe, in the co. of Bucks, for "*Improvements in the production of lighting gas, and in apparatus therefor.*" Aug. 1, 1871.

INVENTION PROTECTED FOR SIX MONTHS ON THE DEPOSIT OF A COMPLETE SPECIFICATION.

1942.—JOHN LEWTAS, of Manchester, in the co. of Lancaster, for "*Certain improvements in the construction of lamps employed for illuminating purposes.*" July 24, 1871.

NOTICES TO PROCEED.

595.—ARNOLD BUDENBERG, of the firm of Schaffer and Budenberg, of Lower King Street, in the city of Manchester and co. of Lancaster, for "*Improvements in pumps.*" A communication. March 6, 1871.

637.—JOHN CHAMPNEY BOTHAMS, of Salisbury, in the co. of Wilts, civil engineer, for "*Improvements in the construction of pipes for the conveyance of sewage or other fluids.*" March 10, 1871.

677.—WILLIAM BURNET ROBINS, of 1, Upper Gordon Street, Euston Square, in the co. of Middlesex, for "*Improvements in portable and hand pumps.*" March 14, 1871.

695.—PETER SALMON, of 5, Mabledon Place, London, for "*Improvements in oil gas-engines, and boilers and apparatus connected therewith.*" March 16, 1871.

717.—WILLIAM PURVIS WILSON, of Addiscombe, in the co. of Surrey, for "*Improvements in apparatus used in the manufacture of gas, which improvements are also applicable to other purposes.*" March 17, 1871.

729.—JOHN RICHARDSON WIGHAM, of Albany House, Monkstown, in the co. of Dublin, Ireland, for "*Improvements in the mode of and apparatus for illuminating lighthouses and beacons, and also other localities where signal-lights are employed.*" March 18, 1871.

746.—JOHN BUSCH, of Oldham, in the co. of Lancaster, gas engineer, for "*Improvements in apparatus for regulating the pressure and flow of gas.*" March 20, 1871.

845.—ALEXANDER ANGUS CROLL, of Coleman Street, in the City of London, for "*Improvements in the treatment of ammoniacal liquor to obtain salts of ammonia.*" March 29, 1871.

893.—JOHN ROWLEY and JAMES HUMPHREY, both of Leeds, in the co. of York, mechanics, for "*Improved apparatus for measuring fluids or liquids.*" April 4, 1871.

1092.—ALFRED BORGNET, of Swansea, in the co. of Glamorgan, manufacturer, for "*Improvements in the manufacture of retorts, muffles, and pots.*" April 25, 1871.

1382.—SAMUEL BROTHERS DARWIN, of Shrewsbury, in the co. of Shropshire, for "*Improvements in apparatus used in the manufacture of gas.*" May 23, 1871.

1447.—SILAS NICHOLLS, of Bristol, in the co. of Somerset, for "*An improved watering-cart or liquid manure distributor.*" May 31, 1871.

1695.—MIGUEL PINDER, of Faro Algaroe, Portugal, but at present of Walworth, in the co. of Surrey, for "*Improvements in joints for pipes.*" June 29, 1871.

1713.—WILLIAM ROBERT LAKE, of the firm of Haseltine, Lake, and Co., Southampton Buildings, London, patent agents, for "*Improvements in mechanism for operating the valves of water-meters.*" A communication. July 1, 1871.

1745.—JESSE HILDRED, of Batley, in the co. of York, borough surveyor, for "*Improvements in apparatus for ventilating and trapping sewers, and for affording access thereto.*" July 4, 1871.

1754.—JOHN BAKER, of St. Mary's Road, Southampton, in the co. of Hants, for "*Improvements applicable to water-closets for deodorizing and counteracting the noxious effluvia emitted therefrom.*" July 5, 1871.

1797.—THOMAS WHITWELL, of the Thornaby Iron-Works, Stockton-upon-Tees, in the co. of Durham, for "*Improvements in valves.*" July 8, 1871.

1940.—ISAAC BROWN, of Elm Croft Grange, Edinburgh, in the co. of Mid Lothian, N.B., for "*Improvements in the irrigation of land, the watering of streets and roadways, and in the apparatus to be used for such purposes.*" July 22, 1871.

PATENTS WHICH HAVE BECOME VOID

BY REASON OF THE NON-PAYMENT OF THE ADDITIONAL STAMP DUTY OF £50 BEFORE THE EXPIRATION OF THE THIRD YEAR.

2261.—DANIEL WEBSTER, "*Certain improvements in the manufacture of gas, and in apparatus connected therewith.*" July 18, 1868.

2266.—WILLIAM BERRY, "*Improvements in the means or apparatus for lighting shops, rooms, and other places, from the outside of the building, by gas, oil, or other illuminating materials.*" July 18, 1868.

2283.—ALFRED HOMFRAY, "*Improvements in separating coal, cokes, and breezes from bats and other impurities, and in machinery or apparatus to be employed for that purpose, which improvements and machinery or apparatus may be applied to the separation of various other substances.*" July 20, 1868.

WEEKLY METAL REPORT.

(*From* J. BERGER SPENCE & Co.'s *Circular.*)

METALS.—A steady and very satisfactory amount of business is being done with Metals of all descriptions, and all connected with the trade appear to be looking forward even more hopefully to the future. The Iron trade is of immense magnitude, and although the exports of Iron and Steel of all kinds have been rather less in the seven months of this year than last year, yet the exports of last month exceeded those of July, 1870, by nearly a quarter of a million sterling. There appears almost no limit to the sale of Pig Iron. Scotch Pig holds an onward course, and Middlesborough is selling freely at current rates. Copper remains unchanged. Tin is very firm, with an upward tendency. A very good trade is being done in Lead, and further demand seems probable, for dead-weight to the East; value may, therefore, rise a little. Spelter quiet.

Share List of Metropolitan Gas Companies.

Number of Shares issued.	Amount per Share.	Name of Company.	Amount paid up p. Share.	Dividend p. Cent. p. Annum.	Latest Quotations.
	£		£ s. d.	£ s. d.	£
8000	20	Anglo-Romano	20 0 0	10 0 0	21 — 23
5000	20	Bahia (Limited)	20 0 0	3 0 0	12½ — 13
1000	20	Do., preference	20 0 0	10 0 0	24 — 25
750	20	Do., do., redeemable	20 0 0	10 0 0	21 — 23
40000	5	Bombay (Limited)	5 0 0	6 15 0	6⅞ — 7
10000	5	Do., third issue	4 0 0	6 15 0	1¼—1⅞ pm.
10000	20	British (Limited) (Norwich, Hull-Sculcoates, Hanley, Tunstall & Shelton [Potteries], Trowbridge., and Holywell.)	20 0 0	10 0 0	35 — 36
7500	20	Cagliari (Limited)	20 0 0	7 0 0	19½— 20½
112000	10	*Chartered*	10 0 0	8 0 0	15½— 16
10000	10	Do., B shares, 4 per cent. max.	10 0 0	4 0 0	7¼— 7⅝
25000	10	Do., 5 per cent. preference	10 0 0	5 0 0	13⅛— 13⅝
20000	10	Do., 5 per cent. preference, second issue	8 0 0	5 0 0	2¼—2⅜pm.
20000	10	Do., 10 per cent. preference	10 0 0	10 0 0	19⅞— 20⅛
17490	25	*Commercial*	25 0 0	10 0 0	43 — 45
20000	20	Continental Union	20 0 0	8 0 0	26 — 28
10000	20	Do., new	7 10 0	8 0 0	3—4 pm.
5213	20	Do., preference (France: Strasbg., Cette, Nismes, Montargis, Vienne, Roanne, Beaucaire, Rueil, Albi. Italy: Milan, Genoa, Parma, Modena, Alessandria, Messina.)	20 0 0	7 0 0	25 — 27
5000	10	*Crystal Palace District*	10 0 0	10 0 0	17 — 17½
5000	10	Do., preference	10 0 0	6 0 0	12 — 13
6044	10	Do., new shares	10 0 0	7 0 0	13 — 13½
3956	10	Do.	1 0 0	7 0 0	1½—1⅝ pm.
23406	10	European (Limited)	10 0 0	11 0 0	16 — 16½
12000	10	Do., new shares (Boulogne, Amiens, Rouen, Caen, Havre, & Nantes.)	5 0 0	11 0 0	3½—3⅝pm.
5000	10	Hong Kong (Limited)	10 0 0	10 0 0	13½— 14½
1560000	50	*Imperial*	100 0 0	10 0 0	177 —179
26000	12½	Do., new shares	12 10 0	7 0 0	16¼— 16⅞
25000	12½	Do., new shares, 1870	5 0 0	7 0 0	2⅞—3¼ pm.
1300	100	Do., bonds	£100	10 0 0	190 —195
56000	50	*Imperial Continental* (Amsterdam, Berlin, Ghent, Hanover, Lille, Rotterdam, Aix-la-Chapelle, Antwerp, Bordeaux, Brussels, Cologne, Frankfort-on-Maine, Haarlem, Stolberg, Toulouse, & Vienna.)	43 15 0	9 2 6	68 — 69
400	100	Imperial Mexican (Limited)	100 0 0	nil.	
200	100	Do., new	100 0 0	nil.	
3000	40	*Independent*	40 0 0	10 0 0	68 — 70
3000	10	Do.	10 0 0	5 0 0	8 — 9
3000	20	Do.	17 0 0	7 10 0	4 —5 pm
230000	Stk.	*London*	100 0 0	10 0 0	175 —178
24000	Stk.	Do., 1st preference	100 0 0	6 0 0	120 —122
	Stk.	Do., 2nd preference	100 0 0	6 0 0	
	Stk.	Do., 3rd preference	100 0 0	6 0 0	
£18781	100	Do., 1st preference stock	100 0 0	6 0 0	121 —123
£11828	100	Do., 2nd preference stock	100 0 0	5 0 0	103 —105
15000	5	Nietheroy, Brazil (Limited)	5 0 0	5 0 0	4 — 4¼
6000	5	Malta and Mediterranean (Limited)	5 0 0	7 0 0	5⅜— 5⅝
20000	5	Do., preference	2 0 0	6 0 0	2⅜— 2⅝
30000	5	Mauritius (Limited)	5 0 0	10 0 0	7¼— 8¼
30000	5	Oriental (Calcutta)	2 10 0	10 0 0	1¼—1⅝ pm.
10000	5	Do., new shares	5 0 0	nil.	2 — 2¼
14000	10	Ottoman (Limited)	10 0 0	8 0 0	10½— 11⅛
27000	20	Pará (Limited)	20 0 0	10 0 0	35½— 36⅜
3600	100	*Phœnix*	40 0 0	7 10 0	53 — 55
144000	Stk.	Do., new	100 0 0	5 0 0	89 — 91
5000	20	Do.	20 0 0	10 0 0	33 — 35
	20	*Rateliff*	20 0 0	10 0 0	33½ — 34½
6959	5	Rio de Janeiro (Limited)	5 0 0	6 0 0	
2000	5	Singapore (Limited)	5 0 0	7 10 0	
1500	33⅓	Do., preference	32 10 0	12 0 0	
4000	50	Shanghai	50 0 0	10 0 0	88 — 90
4000	12½	*South Metropolitan*	12 10 0	10 0 0	21 — 22
20000	12½	Do.	2 10 0	10 0 0	5½—5⅝ pm.
15000	10	Do., new shares	10 0 0	10 0 0	16½— 17½
10000	10	*Surrey Consumers*	6 0 0	10 0 0	5—6 pm.
9000	4	Do., new	4 0 0	5 0 0	3— 3¼
1500	10	United General (Limerick)	10 0 0	10 0 0	13 — 14
1500	10	*Wandsworth and Putney*	10 0 0	7 10 0	7¼— 8
1819	10	Do.	10 0 0	7 10 0	
1138	10	Do.	5 0 0	7 10 0	
20000	10	Western (Limited) A shares	10 0 0	10 0 0	18 — 19
10000	10	Do., B shares	9 0 0	10 0 0	7½—8½ pm.
10000	10	Do., C shares	9 0 0	10 0 0	7¼—8½ pm.
20000	10	Do., D shares	1 0 0	10 0 0	3¼—4 pm.
16000	5	*West Ham*	5 0 0	8 0 0	6½— 7
10000	5	Do., new shares	1 0 0	8 0 0	1¼— 1½
551	10	West London Junction (Limited)	10 0 0	6 0 0	
520	10	Do., preference	10 0 0	6 0 0	

Price Current.

CASTINGS.—*Per Ton.*

Average Weight of Cast-iron Gas-pipes, per Yard.

1 in.	2 in.	2¼ in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	12 in.
16	21	26	33	51	70	89	107	126	149	177	208 lb.

Retail Prices are 5 to 10 per cent. higher.	London.	Glasgow.	Newcastle and Middlesboro'.	Wales.	Yorkshire, Derbyshire, and Staffordshire.
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
Pig Iron, No. 1 (g.m.b.)	4 2 6	3 2 3	3 13 0	3 10 0	3 15 0
1¼ and 2-inch Socket-pipes	7 10 0	6 10 0	6 7 6	6 15 0	7 0 0
2¼ and 3-inch ditto	6 15 0	5 15 0	5 7 6	5 15 0	6 0 0
4 and 5-inch ditto	6 10 0	5 10 0	5 5 0	5 12 6	5 17 6
6 inches and upwards ditto	6 5 0	5 5 0	5 0 0	5 7 6	5 15 0
Retorts, 1st fusion, hot blast	6 0 0	5 0 0	4 15 0	5 10 0	6 0 0
Ditto, 2nd ditto, cold ditto	7 0 0	6 0 0	5 15 0	6 10 0	7 0 0
Tank-plates, ¼ thick and above	6 10 0	5 10 0	5 5 0	6 0 0	6 10 0

SUNDRIES.

Best Newcastle Fire-bricks, per 1000	£2 12s. to £3 15s. 0d.
Cliff's Fire-bricks (at Wortley), per 1000	2 15 0
Ingham's ditto (at Wortley), per 1000	2 15 0
Farnley Iron Co.'s Fire-bricks (at Wortley), less discount	2 17 0
Fire-clay Retorts, per foot run	5s. 6d. to 6 7 6
Tarred Rope Yarn, per cwt.	1 0 0

GAS COALS.

	Per Ton
Newcastle—Unscreened:—	*6s. 6d.*
Haswells, Nettlesworth Primrose, and South Pelaw	
Pelling, Framwell Gate, North Pelton, Redheugh Main, Walker's Primrose, West Wear, and Whitwell Primrose	7 6
Burnhope, Craghead, Charlaw, Derwent, East Castle, Edmondsley, Eighton Moor, Hartlepool Pelaw, Holmside, Lambton's Gas, Lanchester Pelaw, Medomsley, Mickley, New Pelaw, Pelaw Main, Ravensworth, Seaham, South Moor Pelton, South Leverson, Townley Main, Tyne Main, West Pelaw, Wearmouth Hutton, and Witton	7 6
Pearth, Ravensworth Pelaw, Waldridge, West Garesfield, and West Pelton	7 3
Brancepeth, Dean's Primrose, Londonderry Gas, New Pelton, Pelton, South Pearth, Stella, Urpeth, Washington Hutton, and West Leverson	7 6
Ramsay's Newcastle Cannel	17 6
Wigan Cannel (at Liverpool)	17 0

Scotch Cannel, f.o.b.:—	Per Ton.	*Scotch Cannel, f.o.b.:—*	Per Ton.
Boghead—at Bo'ness, *47s. 6d.*; at Leith	*48s. 2d*	Arniston (at Leith)	*21s. 0d*
Muirkirk	27 0	Wemyss (at Wemyss)	20 0
Kirkness, best (at Burntisland)	22 6	Maywood Co.'s Maywood (at Granton)	21 0
Capeldrae, 1st quality (at ditto)	22 6	Pirnie, or Methill	17 0
Ditto, 2nd ditto (at ditto)	17 6	Lothian's Cannel (at Leith)	24 6
Cowdenbeath (at ditto)	13 0	Grange ditto (at Bridgeness)	17 6
Lochgelly (at ditto)	12 0	Kinniel ditto (at Bo'ness)	17 6
Donnibristle—at Burntisland, 12s.; at Aberdour	12 6	Myles' ditto	23 6
Auchinheath Lesmahago (at Granton)	27 0	Lochore Parrot (at Burntisland)	25 0
Duke of Hamilton's Lesmahago (at Granton)	27 6	Waverley Seam (at do.)	16 0
		Lanemark (at Glasgow)	16 0
		Elphinstone Tower (at Leith)	20 0

DUKE OF HAMILTON'S
LESMAHAGOW GAS COAL.

LESSEES:

LESMAHAGOW AND LONGLEE COAL COMPANY,

Office—5, DIXON STREET, GLASGOW.

Works—BLACKWOOD & SOUTHFIELD, LESMAHAGOW.

English and Foreign Agents:

JAMES MILLER, SON, & Co.,

1, GREAT ST. HELEN'S. LONDON, E.C.,

AND

75, UNION STREET, GLASGOW.

WANTED, by an experienced Gas-Fitter, a situation. Understands the manufacture and distribution of gas, also the construction and working of meters. Thoroughly competent to undertake the entire management of Gas-Works. Noblemen or gentlemen having works of their own, or about to have, would find the Advertiser a really valuable servant, he having a good general knowledge of mechanism.

Address GAS-FITTER, Post-Office, Pembroke Place, LIVERPOOL.

WANTED, a situation as Draughtsman in a Gas-Work. Has served a term of six years with one of the best firms of manufacturers in the gas engineering trade. Would not object to assist in book-keeping, or would take a limited engagement to assist in extension, &c.

Apply to H. W., care of Mr. T. W. Grattan, 3, Amen Corner, PATERNOSTER ROW, E.C.

WANTED, an appointment as Manager of Gas-Works, now or in September. Thoroughly understands the manufacture and distribution of gas, main and service laying, gas-fitting, meters, &c. Present making 7,000,000 feet.

Satisfactory reasons for leaving. Testimonials and references.

Address MANAGER, Gas-Works, GODALMING.

TO GAS COMPANIES AND OTHERS.

THE Advertiser is open for an engagement as MANAGER, to enter on duties after September next. He has now the management of a Gas-Work where the make of gas is over 30 millions annually.

Apply to A. D., care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

TO GAS APPARATUS MANUFACTURERS AND OTHERS.

TO BE SOLD, at a very moderate price,
A VALUABLE INVENTION,
SECURED BY LETTERS PATENT,

for a more ready, convenient, and economical arrangement for

FASTENING THE LIDS OF GAS-RETORTS

than has hitherto been employed.

The Invention has undergone many months trial, with the most complete success, and can therefore be confidently recommended.

For particulars, apply to

Mr. W. H. BENNETT,
Patent Agent,
42, PARLIAMENT STREET, WESTMINSTER, S.W.

TO BE SOLD, at the Rhyl Gas-Works, North Wales, 23 15-in. Mouthpieces for Clay Retorts, ascension-pipes, hydraulic main, and delivery pipes complete. One set of 8-in. double vertical Condensers. One Station-Meter (Bent and Co.), with valves and connexions complete, to pass 4000 feet per hour. Four sets of Purifiers, respectively 6 ft. by 3 ft. 6 in., 4 ft. by 5 ft., 4 ft. by 4 ft., with connexions, &c., complete. Large lot of cast and wrought iron, comprising the interior Fittings of a 10,000 feet Gasholder; and sundry other materials.

Applications to MILES R. PARTINGTON, Secretary, Gas Company, Limited, RHYL.

FOR SALE, Three Dry Lime Purifiers, one 12 ft. by 8 ft. by 4 ft. deep, two 8 ft. by 6 ft. by 3 ft. 3 in. deep, with wrought-iron covers, travelling crane, and lifting apparatus, valves, and necessary 6-in. connexions.

For price, apply to J. WILSON, Gas-Works, ABINGDON.

TO GAS COMPANIES AND OTHERS.

FOR SALE CHEAP, a Condenser, consisting of cast-iron box, 9 ft. long, with ten 4-in sockets cast on top; ten 4-in. upright pipes, 9 ft. long and semicircle bends complete.

Also a powerful portable PROVING PUMP, in working order, to prove socket-pipes, &c.

Apply to W. J. HOLLANDS, Iron Merchant, Sun Iron Wharf, Bankside, LONDON, S.E.

FOR SALE, a combined Purifier and CONDENSER, with centre change-valve, suitable for 300 lights. Extreme size 7 ft. 5 in. by 6 ft. by 3 ft. 1 in. high.

Apply to the BRYMBO COMPANY, near WREXHAM.

ON SALE, a good second-hand Station-METER, 8000 feet per hour, Westand Gregson make, bye-pass, &c.

Apply to W. LONGWORTH, Gas Offices, Dukinfield, MANCHESTER.

MODERN STREET LIGHTING, by WILLIAM SUGG, A.I.C.E., price 1s. 6d., is now ready, and will be forwarded post free for 19 stamps.

W. SUGG, Vincent Works, Vincent St., WESTMINSTER, S.W.

PRIVATE TELEGRAPHS FOR GAS AND WATER WORKS.

THE Electric Telegraph Department of our business is most efficiently conducted by an experienced staff. CONTRACTS entered into for maintenance and erection of lines for Gas and Water Companies, private residences, hotels, steamships, &c. Bailey's simple A B C instrument is stronger and less liable to derangement than any other in the market.

Sole makers of L. J. Crossley's Electrical Speed Indicator.

Sole makers of Chatwood's Patent Electrical Ship's Log.

Sole makers of Bailey's dust-proof and damp-proof Signal-Bell.

Managers of Gas and Water Works are invited to ask us for our quotations, or for any information connected with Telegraphy.

JOHN BAILEY AND Co., Turret Clock Makers to the late Earl of Rosse, the British and Foreign Governments, &c., Electric Telegraph Engineers, and General Brassfounders, Albion Works, Salford, MANCHESTER.

THE Directors of the Tottenham and Edmonton Gas Company are prepared to receive TENDERS for 7500 tons of best GAS COAL, as free as possible from dust and pyrites, and about 250 tons CANNEL COAL. The price at per ton to include all charges for delivery, rail direct to the Gas Company's siding at Angel Road Station, on the Great Eastern Railway, in the quantities and at the dates mentioned below:—

1871—September 15	400 tons.
,, October 15	1000 ,,
,, November 15	1100 ,,
,, December 15	1300 ,,
1872—January 15	1400 ,,
,, February 15	1000 ,,
,, March 15	800 ,,
,, April 15	500 ,,
Total	7500 tons.

The Cannel to be delivered in September, October, and November, 1871, in equal quantities each month.

The Coal will be weighed on the Gas Company's weigh-bridge.

Tenders to be sent in, stating name of Coal offered, on or before Friday, the 25th inst., marked on cover, "Tender for Coal."

The Directors do not bind themselves to accept the lowest or any tender. By order,

JAMES RANDALL, Secretary.

Gas-Works, Tottenham, N., Aug. 12, 1871.

IMPERIAL GASLIGHT AND COKE COMPANY.

NOTICE is hereby given, that the ordinary HALF-YEARLY GENERAL MEETING of the SHAREHOLDERS of this Company will be held at 33, John Street, Bedford Row, London, on THURSDAY, the 24th day of August inst., at One o'clock precisely, to receive the Report of the Directors and the Accounts of the Company, and to declare a Dividend for the half year ending the 30th of June last. And notice is also hereby given that it is intended at the same meeting to propose that the Directors be authorized to borrow, on mortgage or bond, under the powers conferred by the Imperial Gas Act, 1869, an amount not exceeding £31,250. By order,

HARRY CHUBB, Secretary.

Offices of the Company, 33 & 34, John Street, Bedford Row, London, Aug. 3, 1871.

EAST BARNET GAS AND WATER COMPANY.

Incorporated 1866.

OFFICES—ALBERT ROAD AND LYTTON ROAD, EAST BARNET, HERTS.

NOTICE is hereby given, that the ELEVENTH HALF-YEARLY ORDINARY GENERAL MEETING of the Company will be held at the Board-Room, at the Works, on FRIDAY, the 25th inst., at Four o'clock p.m.

By order,

W. C. HUMPHRYS, Secretary.

Trains from King's Cross at 3.5 and 3.23 p.m.

Business—To receive the Directors Report and Statement; to declare a Dividend; to elect two Directors in the room of J. T. Bontems, and W. T. Balfour, Esqrs., who retire by rotation, but, being eligible, offer themselves for re-election; to appoint two Auditors, and for general business.

The Transfer Books will be closed from the 15th to the 27th inst. inclusive.

Aug. 10, 1871.

At Messrs. Chadwick's Rooms, 34, St. Martin's Lane, Charing Cross.

TO GAS-FITTERS AND OTHERS.

MR. SCAMELL will SELL by AUCTION, on WEDNESDAY, August 16, about 90 gross of MICA COVERS, and half a ton of ROCK and FIBROUS ASBESTOS, in convenient trade lots. May be viewed on Monday, and on Tuesday and Wednesday mornings.

Catalogues at the Rooms, and of Mr. SCAMELL, 40, Upper Thames Street, LONDON.

RATCLIFF GASLIGHT AND COKE COMPANY.

NOTICE is hereby given, that a HALF-YEARLY GENERAL MEETING of the SHAREHOLDERS of this Company will be held at the Company's Offices, as above, on THURSDAY the 31st day of August inst., at Two o'clock in the afternoon precisely, to declare a Dividend for the half year ended June 30, 1871, and for other general purposes of business. And notice is hereby further given that the Register of Transfers will be closed from the 26th of August inst., to the 31st of August inst., both days inclusive.

By order of the Board,

H. J. BADDELEY, Secretary.

Offices, 345, Cable Street, London, E.

Aug. 14, 1871.

MANUFACTURE AND DISTRIBUTION ACCOUNTS.

Mr. W. J. WARNER

Begs to say that in consequence of the number of inquiries he has received relative to the above form of Accounts, which he had the pleasure of submitting to the

BRITISH ASSOCIATION OF GAS MANAGERS,
AT THEIR LATE MEETING IN DUBLIN,

he has been induced to publish them, and is now prepared to supply the two sheets, post free, for 5s.

Applications to be made to

Mr. W. J. WARNER,
Engineer,
GAS-WORKS, SOUTH SHIELDS.

ALFRED LASS,
ACCOUNTANT,
28, NORTH STREET, WANDSWORTH, S.W.

Mr. Alfred Lass having had considerable experience in arranging, making up, balancing and auditing gas accounts, begs to inform the Directors of Gas Companies that he may be consulted on all matters relating thereto.

Balance-sheets prepared, Accounts audited, Consultations, Agencies, &c.

BOOKS FOR GAS ACCOUNTS.

ALFRED DOUBBLE & Co., 2, Serjeants INN, and 40, FLEET STREET, LONDON, make and supply all the various ACCOUNT-BOOKS as approved and adopted by Accountants, &c., to Gas Companies.

A complete set of the Books and Forms forwarded within a few days from receipt of order.

EDWARD SANDELL, Public Accountant and Auditor, 4, Skinner's Place, Size Lane, LONDON.

The projector of the *Original Gas Companies Analyzed Expenditure Account-Book* offers his experience and services in the examination, preparation, and production of all accounts in reference to Gas Companies. References if required.

SAMUEL PONTIFEX, Consulting Gas Engineer, having retired from the Great Central Gas Company, is now prepared to furnish PLANS and SPECIFICATIONS, as well as ADVISE Provincial Gas Companies as to the erection of new, or alteration and enlargement of existing works.

Offices: 22, Coleman Street, LONDON, E.C.

ALFRED PENNY, Gas and Consulting ENGINEER,
WENLOCK IRON-WORKS,
21, WHARF ROAD, CITY ROAD, LONDON.

Mr. PENNY having had a large experience in the construction, alteration, and management of Gas-Works, begs to inform the Directors of Gas Companies that he may be consulted on all matters appertaining thereto. He also manufactures Gasholders, Purifiers, and all the various apparatus used in Gas-Works, and keeps in stock Retorts and Mouthpieces, Socket-Pipes, Bends, Branches, and T-pieces, &c., &c.

Plans, Specifications, and Estimates prepared.

TROTTER, HAINES, & CORBETT,
BRETTELL'S ESTATE
FIRE CLAY & BRICK WORKS,
STOURBRIDGE.

Manufacturers of GAS-RETORTS, GLASS-HOUSE FURNACE & BLAST-FURNACE BRICKS, LUMPS, TILES, and every description of FIRE-BRICK.

Proprietors of
BEST GLASS-HOUSE POT and CRUCIBLE CLAYS.
Successors to
E. BAKER AND Co., LATE BRIERLEY HILL, STAFFORDSHIRE.

HOPKINS, GILKES, & CO.,
LIMITED,
MIDDLESBOROUGH,
SUPPLY GAS & WATER PIPES of EVERY SIZE.
Plain, Turned and Bored, and Coated.
CAST-IRON RETORTS.
Castings for Gas-Works of every description.
EXHAUSTERS.
LONDON OFFICE: 25, LAURENCE POUNTNEY LANE.

WALTER MABON & CO.,
Engineers,
ARDWICK IRON-WORKS,
FAIRFIELD STREET, MANCHESTER,
MANUFACTURERS OF
IRON TANKS, GASHOLDERS,
GAS APPARATUS,
PIPES, VALVES, IRON ROOFS
WROUGHT AND CAST IRON GIRDERS.
DESIGNS, SPECIFICATIONS, & ESTIMATE FURNISHED.

WATER-WORKS FITTINGS,
SLUICE-COCKS, FIRE-COCKS,
METERS, STEAM FITTINGS,
GAS & HOT-WATER VALVES, &c.,
Of First-class Materials and Workmanship.

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BRASSFOUNDERS & HYDRAULIC ENGINEERS,
GREAT SUFFOLK STREET, SOUTHWARK, S.E.
Illustrated Catalogues on application.

EDGE'S PATENT
FOR REMOVING THE
CARBONACEOUS INCRUSTATION FROM GAS-RETORTS.

"*Gas-Works, Bury St. Edmund's, Oct.* 24, 1870.
"Dear Sir,—In answer to your inquiry about Edge's patent method of scurfing Retorts, I beg to inform you that I can give it my unqualified recommendation.
"Some years ago, in order to facilitate the scurfing process, I introduced open-ended Retorts here, and found them a great improvement upon the common Retorts, which, in addition to the damage they received at scurfing times, were very leaky for several days afterwards. Even with that plan there was a considerable amount of labour and care, which I have avoided since the adoption of Edge's method.
"I find the amount paid for royalty less than the entire cost of open-ended Retorts; and in addition, that less labour is required and less damage is done to the Retort in scurfing.
"As Edge's method does not burn the carbon out of the cracks so much as most other plans, and my stokers are pleased with it, I regard it as invaluable in reducing one of the anxieties of the gas manufacturer.
"Having a steam-engine on the premises, it was easy of adoption here, but my opinion of it is so high that I would recommend all gas managers who are not so situated, to provide themselves with a portable steam-boiler, and am sure that they will never regret the investment.—I am, dear sir, yours truly,
"E. Goddard, Esq." "THOS. H. METHVEN.

For particulars and terms, apply to E. GODDARD, Sole Agent, Gas-Works, IPSWICH.

THOMAS CARR & SON,
MANUFACTURERS OF
FIRE-BRICKS, LUMPS, TILES, RETORTS,
&c., &c.,
SCOTSWOOD FIRE-BRICK WORKS,
NEAR
BLAYDON-ON-TYNE.

BRONNER'S PATENT GAS-BURNERS give 99 per cent. of light, as compared with 27 per cent. given by ordinary burners, with equal consumption of gas.—*Vide* "Gas Referees Report," published June, 1869.
HENRY GREENE AND SON, Sole Consignees of Brönner's Patent Improvements in Gas Lighting, 16 and 17, King William Street, E.C., and 138, Regent Street, LONDON. Agents wanted.

CAST-IRON Retorts, Socket-Pipes, with Syphons, and all requisite Connexions, Lamp Columns, Wrought-Iron Tubing, Valves, Street-Lamps, Sight Holes, Furnace Doors, Ash-Pans, Charging and Coke Shovels, Iron Pails, Coke Barrows, Cross Bars, Fire Pots, Pumps, and Iron Borings.
PURIFIERS, CONDENSERS, & SCRUBBERS erected complete, or the materials supplied; and every description of goods in use by Gas-Works, in stock, at wholesale prices, at
Mr. LYNCH WHITE'S,
Old Barge Iron Wharf, Upper Ground Street, LONDON.

Established 1811.
READY & SON,
BILSTON STREET BRASS FOUNDRY,
WOLVERHAMPTON,
MANUFACTURERS OF
SUN BURNERS, GAS CHANDELIERS,
HALL LANTERNS, BRACKETS, PENDANTS,
And every Description of
GAS-FITTINGS,
Including
MEDIÆVAL FITTINGS FOR CHURCHES, &c.
Large Pattern-Books complete, with Book of Prices, 7s. 6d.

C. & W. WALKER'S GAS-VALVES.
These celebrated Valves of all kinds have been in use for so many years, and are so well known, that a description is unnecessary.
They are made of all kinds to suit all the requirements of engineers.
Midland Iron-Works, Donnington, near Newport, Shropshire; 8, Finsbury Circus, London.

LAMBERT BROTHERS, WALSALL.
ALPHA TUBE & FITTING WORKS

ECONOMY IN GAS PURIFICATION. A PURER GAS AT LESS COST, AND GREAT SAVING IN LABOUR.
M'DOUGALLS' PRECIPITATED PEROXIDE OF IRON.
The above Oxide is now in use at some of the largest works in the kingdom, and has gained a decided preference, owing to its efficiency, cheapness, and the great saving in labour effected by its use.
It is a pure artificial Hydrated Peroxide, with an addition of only sufficient sawdust to give it the needful lightness or porosity to prevent pressure, and every particle is available for use.
In selecting an oxide, a point more important than its price, is to learn the cost of labour entailed in its use. Whilst at large works the cost of labour for purifying, where lime alone or the natural oxides are employed, is 2d. to 3d. per ton of coals, by the use of the above Oxide it is reduced to 1d. to 1½d., owing to the purifier's working so much longer when charged, and to rapid revivification—two points of special importance in the busy season.
For export to Foreign Works it is unequalled, every particle being available, and saves freight over less concentrated materials.
NOTE.—It is important to note that only the Hydrated Peroxide of Iron is useful, simple oxide being worthless. Inferior oxides show a large per centage of simple oxide, but very little Hydrated Peroxide.
M'DOUGALL BROTHERS,
LONDON—158, LEADENHALL STREET, E.C. MANCHESTER—68, PORT STREET.

LIVESEY FIRE-CLAY WORKS,
NEAR BLACKBURN, LANCASHIRE.
(ESTABLISHED 1835.)
ORLANDO BROTHERS,
MANUFACTURER OF PATENT CLAY RETORTS,
AND EVERY DESCRIPTION OF
TUBULAR GLAZED SEWERAGE PIPES, BENDS, JUNCTIONS, ETC.
FIRE-BRICKS, TILES, BLOCKS, AND CHIMNEY-TOPS.

As Trustees of the late ORLANDO BROTHERS, we most respectfully announce that we intend to continue the above business, under the name of ORLANDO BROTHERS, in which name all communications must be addressed.
We trnst that we shall receive a continuance of the same support which was given to our late father.
We are, yours most respectfully,
ORLANDO BROTHERS.
FRANCIS W. BROTHERS.
COLIN BROTHERS.

THOMAS PROUD,

GAS ENGINEER,

Invites attention to his

WOOD GRIDS

FOR PURIFIERS,

And respectfully states that he has erected improved Steam Machinery for their manufacture, and devotes great care to supply Grids which will give satisfaction.

He also solicits attention to his

IMPROVED GAUGE

which indicates pressure or vacuum in ONE TUBE. Having but one joint, the Gauge can be taken asunder, cleansed, and refixed in a few minutes.

Plans and estimates furnished for improvement of existing, or for the erection of new Gas-Works.

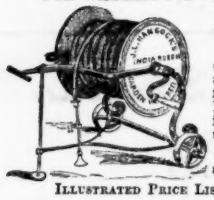
Gas Apparatus Manufactory,

7, UNETT ST., ST. GEORGE'S,

BIRMINGHAM.

HANCOCK'S INDIA-RUBBER HOSE-PIPES,

FOR WATERING GARDENS, LAWNS, &c.



Made in 60 ft. lengths, and best make only.

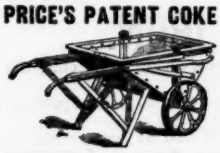
Brass branches, with stop-cocks, jets, and spreaders, and union joints for connecting any size Hose. HOSE REELS (galvanized iron or painted) for winding up the Hose.

Orders promptly executed, and

ILLUSTRATED PRICE LISTS ON APPLICATION.

JAMES LYNE HANCOCK, Vulcanized India-Rubber Works, Goswell Mews, and 266, Goswell Road, LONDON, E.C.

PRICE'S PATENT COKE & COAL BARROW,



effecting a great saving of time, labour, and expense.

For particulars, price, &c., apply to Mr. E. PRICE, Inventor and Patentee, Gas-Works, Hampton Wick, MIDDLESEX.

THOMAS LAMBERT & SONS,

SHORT STREET, LAMBETH, LONDON

PATENTEES OF THE

HIGH-PRESSURE EQUILIBRIUM BALL VALVES AND DIAPHRAGM BIB & STOP VALVES,

MANUFACTURE EVERY DESCRIPTION OF

GAS-JOINTS, CHANDELIERS, PENDANTS, BRACKETS, ETC.;

WROUGHT-IRON WELDED TUBE AND FITTINGS,

BLACK AND GALVANIZED;

BRASS, COPPER, LEAD, TIN, AND COMPOSITION TUBING,

STOCKS, TAPS, AND DIES,

And Every Description of Gas-Fitters Tools;

IRON MAIN COCKS, WITH WHITE METAL PLUGS;

GAS SLIDE AND SLUICE VALVES;

CARTER'S SAFETY GAS-VALVES;

GAS-STOVES, REGULATORS, BURNERS, &c.,

Large Pattern-Book and Price List of Gas-Fittings, price 7s. 6d., supplied on application.

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(Established 1820,)

FIRE-BRICK AND TILE MERCHANTS,

Wholesale and for Exportation,

FALCON DOCK, 78 AND 79, BANKSIDE,

SOUTHWARK, LONDON, S.E.,

DEPÔT for STOURBRIDGE AND NEWCASTLE FIRE-BRICKS, LUMPS, TILES, and FIRE-CLAY, and every Article suitable for

GAS AND WATER WORKS.

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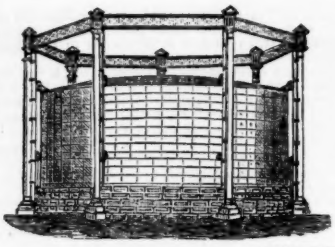
CONTRACTING GAS ENGINEERS,

GASHOLDER & GENERAL GAS APPARATUS MAKERS,

MANUFACTURERS OF

BOILERS, IRON ROOFING, IRON BRIDGES,

AND GENERAL IRONWORK.



S. C. AND SONS undertake Contracts of any magnitude for the **Erection of new and Remodelling of existing Gas-Works**, for **Gasholders, Cast and Wrought Iron Tanks, Iron Roofs**, and every description of **Apparatus** for the Manufacture and Distribution of Gas.

Special attention is invited to their **"Improved Condenser,"** which is very effective, and much approved; also to their patterns of **Annular** and other **Condensers, Scrubbers**, and **Purifiers**, of all sizes, which they arrange either with **Centre** or Ordinary **Slide Valves.**

WORKS FOR THE SUPPLY OF

VILLAGES, MANSIONS, FACTORIES, &c.

S. C. AND SONS undertake the **Supply** and **Laying** of **Mains** for **Gas and Water**, and supply all Castings, Connexions, and Fittings for Retort-House, Works generally, and for Streets. They also supply **Valves** of all descriptions, Iron and Clay Retorts, Hotpressed Retort-Lids, Steel Charging-Scoops of improved make, for which they have special machinery, Improved Coke and Coal Barrows, Cross-Bars and Screws, Bolts and Nuts, Furnace and Stoking Tools, Iron and Wood Purifier-Sieves, Lead, Yarn, Borings, &c., including every requisite whatsoever for a Gas-Work, a well-assorted stock being kept of those goods most in request.

SOLE MAKERS OF BRETT'S PATENT COKE BARROW.

Experienced Retort Setters sent to any part of the Kingdom.

Address: PROVIDENCE IRON-WORKS, MILLWALL, LONDON.

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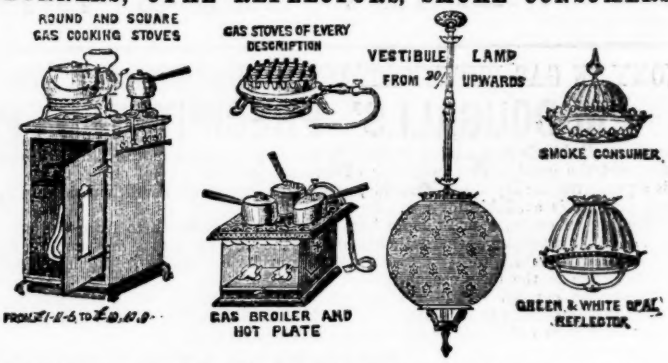
MANUFACTURERS TO THE TRADE

OF EVERY DESCRIPTION OF

GAS-STOVE FOR HEATING OR COOKING,

GAS-BURNERS, OPAL REFLECTORS, SMOKE CONSUMERS, &c.


ROUND AND SQUARE GAS COOKING STOVES
GAS STOVES OF EVERY DESCRIPTION
VESTIBULE LAMP FROM 20/ UPWARDS
SMOKE CONSUMER
GAS BROILER AND HOT PLATE
GREEN & WHITE OPAL REFLECTOR

Pattern-Books, with Prices and Discounts, sent free on application.

REDUCED PRICES

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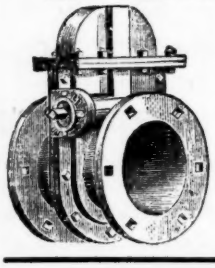
IMPROVED GAS-VALVES

WITH WROUGHT-IRON PINIONS,

From 2 inches to 18 inches, price 9s. 6d. to 12s. per inch diameter.



List of prices, with full dimensions of all sizes up to 48-inch, to be had on application.

These Valves are all proved on both sides to 30 lbs. on the square inch before leaving the works, and are always kept in stock.

VALVES MADE WITH OUTSIDE RACKS TO ORDER.

ALSO,

SCREW WATER-VALVES WITH GUN-METAL FACES.

B. DONKIN & CO.,

GENERAL ENGINEERS AND IRONFOUNDERS,

MAKERS OF STEAM-ENGINES,

BERMONDSEY, LONDON, S.E.

THE PATENT RIBBED GAS-RETORTS

Are in Use at over 150 Gas-Works,

And continue to give entire satisfaction. Circulars, with prices and testimonials, will be sent on application to

A. C. FRASER, GAS-WORKS, MIDDLESBROUGH.

JOHN HALL & CO.,

STOURBRIDGE,

MANUFACTURERS of FIRE-BRICKS, LUMPS, & TILES,

AND EVERY DESCRIPTION OF FIRE-CLAY GOODS.

N.B.—A Stock of 15 and 16 in. CIRCULAR RETORTS always on hand. Other kinds made to order on short Notice.

PARIS, 1867.

CLASSES 24 and 53.

WILLIAM SUGG,

GAS ENGINEER.

LONDON, 1862.

CLASSES 13 and 31.

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Analyses by F. J. EVANS, Esq., Chartered Gas Company, Horseferry Road, Westminster:—

(COPY.)

Description.	Cubic Feet of Gas per Ton of Coals.	Illuminating Power in Candles.	Coke per Ton of Coal used. Cwt.	Ash in Coke per Cent.	Sulphur in Coa per Cent.
Best Silkstone . .	10,900	17·0	12·8	2·6	1·7
Norfolk Silkstone . .	11,000	15·94	12·5	4·4	1·64
Silkstone Brights . .	11,500	14·5	12·6	7·4	1·85
Silkstone Nuts . .	10,800	15·85	12·66	6·0	0·69

NOTE.—The illuminating power of the Gas was tested by the standard burner now used in London by the Gas Referees, under the City of London Gas Act, 1868.

Horseferry Road, Westminster, March, 1870. (Signed) F. J. EVANS.

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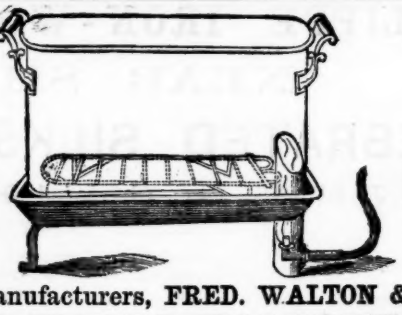
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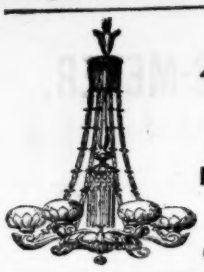

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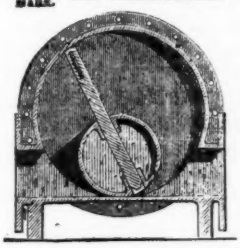

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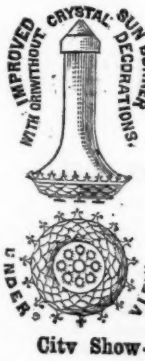

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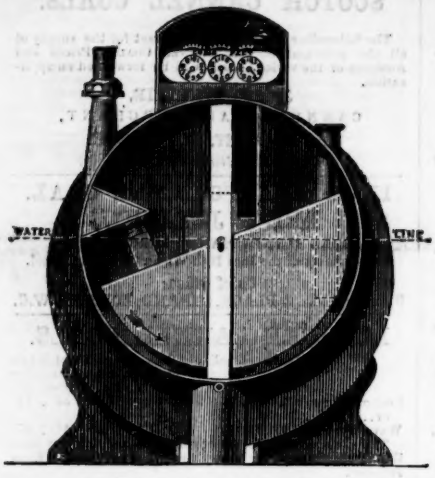

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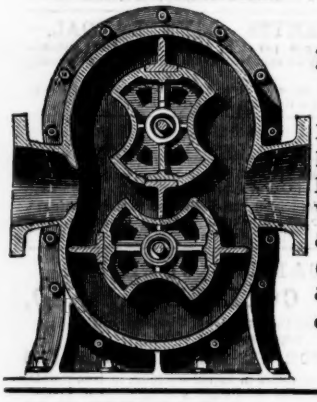

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